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# JPRS Report

# Science & Technology

## Europe

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## Europe

JPRS-EST-90-004 | CONTENTS | 7 FEBRUARY 1990

## FACTORY AUTOMATION, ROBOTICS



## LASERS, SENSORS, OPTICS



## MICROELECTRONICS

# ADVANCED MATERIALS

## FRG University Studies High-Performance Materials

*90MI0044 Bonn TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN in German No 511, 15 Sep 89 pp 8-9*

[Text] Prof H. Mughrabi and Dr H.A. Kuhn are currently carrying out basic research on the strength of materials at the Erlangen- Nuernberg University Institute of Material Sciences. It has long been known that a material's strength is linked to its structure, i.e., its microscopic structure. It is the "internal tensions" that primarily counter external mechanical stresses, thus creating strength. It is also known that these tensions are caused by minute irregularities in the regular structure of materials. The problem of how they can be detected qualitatively and thus grasped scientifically has not yet been solved. The scientists in Erlangen now intend to use high definition microscopic methods to measure atomic range deviations from the regular material structure, which ultimately cause these internal tensions, more accurately than ever before. The Volkswagen Foundation is providing DM700,000 to fund this research as part of its program on the microcharacterization of materials and components.

Modern technology makes the highest demands on materials and their strength. For example, multiphase high-temperature alloys that maintain their strength without becoming brittle or soft even above 1000° C are used in power plant turbines. But in the final analysis, what determines strength in technical materials? The microscopic structure of a material must be characterized if we are to understand its properties. Its strength depends primarily on the aforementioned internal tensions. According to Mughrabi's research to date, these tensions are linked to distortions in the material's atomic structures.

The goal of the project, which is scheduled to last three years, is to accurately measure the lattice distortions and lattice parameter modifications of these materials and to systematize and classify them. This necessarily leads to attempting measurements that are far below the definition range of a normal microscope. To observe modifications in the lattice parameters, the capacity to register dimensions on the order of tenths of a nanometer must be created (one nanometer equals $10^{-9}$ m). Mughrabi and Kuhn are planning measurements both with convergent electron beams in a transmission electron microscope (CBED [convergent beam electron diffractography] process) and with the more highly integral method of X-ray diffraction. Both methods can be used to detect lattice parameter modifications in the $10^{-10}$ m range. By combining the results of both experiments, a clear correlation between lattice distortions and defined microscopic ranges can be established.

Both monophase model materials and multiphase high-temperature alloys similar to those used in practice will be studied. The results are expected to be used in further developing microscopically based models for describing the macroscopic deformation behavior of metal materials.

For further information, contact Prof H.A. Kuhn, Erlangen-Nuernberg University Institute of Materials Sciences, Martensstr. 5, 8520 Erlangen, tel. 09131-857501.

## Italy: New Research Program Presented

*90MI0036 Milan ITALIA OGGI in Italian 24 Oct 89 p 30*

[Text] The new national program for innovative materials developed by the Ministry of Universities and Research, which will initially receive 200 billion lire in funding, was presented to the CNR [National Research Council] yesterday by Research Minister Antonio Ruberti and by the coordinator of the National Council for Advanced Materials, Romano Cipollini.

The program requires a total investment of 500 billion lire over a 5- year period, but the initial 200 billion lire funding should be approved by the CIPE [Interministerial Committee for Economic Planning] by 31 December. Of this amount, 70 billion will be allocated for training programs, while the remainder will be targeted for research in five key areas of the new materials sector. These include structural materials for civil and industrial constructions, heat resistant and thermomechanical materials, electromagnetic materials, superconductors, and biocompatible materials for applications in the medical sector.

"In the area of new materials," Ruberti stated, "Italy has a demanding task in terms of technological development and its competition with the European Community, the United States, and Japan. In this regard," the research minister added, "it is necessary to reform Law 46 concerning the allocation of funds to industrial research." Finally, Ruberti noted that the reform proposal is now being examined by the Council of Ministers, the goal being "to widen and create a more flexible range of financing procedures."

Italy has spent an average of 75 billion lire a year to date for research on advanced materials, and in Europe, ranks last after the UK (150 billion), France (200 billion), and the FRG (300 billion). The United States spends approximately one trillion lire a year in this sector.

On the basis of the national program submitted to the CNR yesterday, investments for the next 5 years should total 140 billion lire for structural materials, 130 billion for thermomechanical materials, 100 billion for electromagnetic materials, 34 billion for superconductors, and 55 billion for biocompatible materials. "In the last category," Romano Cipollini noted, "the research centers should primarily be established in the South because these facilities are entirely new to Italy, whereas the center and north of the country would exploit facilities that are already operational."

According to Carlo Eugenio Rossi, chairman of the Fiat Research Center, approximately 50 percent of the investments should be made in the South, even in the field of structural materials.

The national program, together with the CNR's finalized targeted project for special materials, is a means to implement the national plan for innovative materials launched by the Ministry for Universities and Research. The program's original budget of 500 billion lire will be supplemented with an additional 85 billion from the CNR's finalized project, and with an additional 13 billion which had previously been requested to launch a subproject for biocompatible materials.

## AEROSPACE, CIVIL AVIATION

### DARA Director on FRG Space Policy

*90CW0056 Stuttgart FLUG REVUE in German Nov 89 pp 18-19*

[Interview with Wolfgang Wild, DARA director, by Goetz Wange, date and place not given: "Empty Boxes in Space Are of No Use to Anyone"; first paragraph is FLUG REVUE introduction]

[Text] The German Agency for Space Affairs (DARA) is intended, as a "German NASA," to provide better representation of German interests on the international scene. So far, director Prof Wolfgang Wild, former Bavarian State Minister for Science and Art, has had his hands full setting up a powerful organization. In an interview with FLUG REVUE, he reveals for the first time the major points of emphasis he will pursue in the future in FRG space policy.

FLUG REVUE: What changes must DARA implement for German activities in space to progress better than before?

*Wild:* DARA was established first and foremost to make the management of the FRG space program as efficient as that of the French, for example, where CNES [National Center for Space Studies] has been in place since 1962. CNES has basically the same duties as DARA, but with a few differences. CNES has strategic duties as well. In the FRG, this type of coordination has not existed before. DARA is supposed to assume jurisdiction based on the Space Duties Assignment Law and thus be able to take care of many things which formerly required ministerial action.

FLUG REVUE: Why is it taking so long to get on with the national space program?

*Wild:* The decision was made at the last meeting of the secretaries of state that DARA should be substantially involved in the design of this space program. From the standpoint of staff, DARA will not be able to do this until fall of 1990. However, that is the period just before the national elections; therefore, it was decided that the fifth space plan would not be submitted until the next session of parliament. I believe that is the appropriate decision, although I would have also been pleased if it had been possible to adopt the fifth space plan during this session of parliament.

FLUG REVUE: In your opinion, what points of emphasis should be pursued?

*Wild:* First: I attach great importance to earth observation. Environmental issues are in fact the aspect which justifies space flight in the eyes of the general public. We are in the process of causing a great change in the world's climate in a wide variety of ways, through the greenhouse effect with carbon dioxide, through degradation of the ozone layer, which has been triggered recently not only by chlorofluorocarbons but also by the deforestation of the tropical rain forests. Space flight can make significant contributions toward determining what is happening here and being able to control the chemical processes in the ozone layer and in the lower layers of the atmosphere. Second: Applications must under no circumstances be restricted so much through outlays for the infrastructure that we end up with magnificent structures in space but are no longer able to perform the essential experiments. Third: We must look beyond the year 2000. And, there, I would attach considerable importance to the Saenger project.

FLUG REVUE: Compared to France, the funds spent for the national program are still relatively modest. Will it be possible to change this under DARA?

*Wild:* I would be very pleased if things changed. One of the strengths of the French was that they were able to forge ahead with projects on the national level which were so well-founded that they have been adopted as European projects. Hermes and Ariane are typical examples. So far that has not occurred in Germany.

FLUG REVUE: Within the framework of the ESA program the German emphasis is on the Columbus space station. There are studies before your agency which make it clear that appropriate exploitation of the space station cannot be financed. What do you think of these studies?

*Wild:* Time will tell what can ultimately be financed and what cannot. The amounts projected for 1990 can be financed. Long-term plans in which we actually run into bottlenecks could lead to our having to spend inordinately large amounts for the infrastructure and then having to make cuts in the applicational programs. We simply must not get into that situation. We must consider whether by a slight change in the current schedule will free up funds for financing, or—and I would welcome this—whether we could manage to convince the general public that the funds must be raised here to make this coherent program truly worthwhile.

FLUG REVUE: What could be done to keep the programs alive and still economize?

*Wild:* There are an infinite number of models which could be considered. For example, and this is the simplest way, the entire program could be stretched out over a longer period without giving up anything in terms of the projects. Another model would involve cutting some of the fat out of one element or another, such as designing a less expensive rescue system for Hermes. I don't wish to go into these matters in detail right now, otherwise there would be a lot of speculation again. In any case, the committee of the secretaries of state asked us to develop and propose a number of alternative models including their costs.

FLUG REVUE: What percent of the costs identified in the ESA's long-term program—i.e., approximately DM65 billion over 10 years—do we have to cut?

*Wild:* To pay the German share and to retain appropriate applications and infrastructure, we need at least DM28, preferably DM30, through the year 2000. According to current framework plans, we would have to reduce our contribution to from DM23 to DM24. I don't think we can reasonably make a reduction of this magnitude, but we will have to consider certain economies. Certain parts of the national programs are also included here, but these would not be lavishly covered even with the DM30 billion, and they would naturally have to be redesigned even more frugally in the event of a reduction.

FLUG REVUE: What are the strengths and weaknesses of German space activities?

*Wild:* The strengths of the German space activities definitely lie in the scientific arena. In this area we are fully competitive. We are the leader in the field of microgravity; in this application we are second to none. We are also very good in our ability to deliver technical items. Parts which we have supplied for European space projects are described as extraordinarily reliable and very high quality. To my knowledge, parts delivered by German firms have never been the cause of breakdowns. Where we lag behind the French is in the planning and implementation of very large systems. We must also take care not to be overtaken by the Italians, who are becoming very active in this area.

FLUG REVUE: The Germans have really gone out on a limb with the Saenger project. Hasn't a technical solution which will necessitate later Europeanization been presented too early in this case?

*Wild:* I am not convinced that anything was formulated too early. Opinions vary widely because it is certainly true that the Saenger project is linked to a large number of imponderables, especially with regard to the propulsion system. Whether what has been included in the design is actually feasible is not yet certain. On the other hand, there is a fascination in such demanding tasks. And, all in all, that is the wonder of the space program: that tasks are established which go beyond what is possible today. There is an immense drive to create a power unit that can go as fast as Mach 7. In my opinion, it was appropriate to set this high requirement.

FLUG REVUE: ESA director Luest has said in response to German criticism of the European shuttle: "Without Hermes no Saenger"; and the [FRG] federal government's coordinator, Secretary of State Dr Erich Riedl, stated at the same press conference "Without Saenger no Hermes." Does this mean that the [FRG] federal government intends to make a package deal of the Europeanization of Saenger and continued support for Hermes, which is up for a decision in 1991?

*Wild:* Mr Riedl's statement is in fact worthy of note. Before this, I had not heard it stated this categorically by any member of our federal government. In principle, it is already obvious to me. Hermes is legitimized first and foremost as a technological stepping stone to achieve the necessary expertise in the shuttle area. Of course, it also has some functions within the Columbus program: the servicing of the MTFF [Man-Tended Free Flier]. But I see the significance of Hermes much more in its role as a technological stepping stone. And this much is certainly true: No Saenger without Hermes. We need this stepping stone; otherwise, the goal would certainly be unattainable. However, Hermes can only be justified through subsequent technology, and that could be, that must be, Saenger.

FLUG REVUE: If a less demanding crew rescue system is adopted for Hermes, the German subsystem responsibility is no longer so substantial. Would you then work toward having at least one flight unit of Hermes integrated in the FRG as a trade-off?

*Wild:* This is a question of finances, but it is also a question of reliability. You would have to satisfy the same specifications in two locations, and then the political question would also ultimately come into play here: Is it worth it to us, given tight finances...

FLUG REVUE: Does it have to be worth it to us?

*Wild:* We should concentrate our efforts elsewhere. If, for example, we are successful in getting Saenger adopted as a European project, that is—I feel—much more important than any Hermes integration in Germany.

FLUG REVUE: There will be a stepping stone—the sixth generation Ariane—before fully reusable systems can be produced. One major emphasis will be the retrieval of the expensive first stage, as revealed by the Dornier EARL study. Will you work to see that there is a significantly greater German share in the sixth Ariane project than the mere 22 percent of the past?

*Wild:* I would consider it a wise move to increase the German share from Ariane 5 to Ariane 6. Of course, even that is ultimately still a question of the funds available. Applications must not be short-changed by infrastructural programs—and I attach the greatest importance to this.

FLUG REVUE: Will you try to obtain German responsibility for one stage of Ariane 6 even in the development phase?

*Wild:* I would consider that very useful.

FLUG REVUE: In France, very concrete studies for military reconnaissance satellites have been in existence for a long time. These also find support in parts of the [FRG] federal government, especially as instruments to monitor arms reduction agreements. Is a decision forthcoming on this?

*Wild:* That is still very much in a state of flux. In this country, the chancellor's office is responsible for these verification satellites. I am convinced that such a reconnaissance system will be developed. At the moment it is still very much up in the air whether it will be implemented on the national level or as an international or bilateral project. The only question is whether these satellites can perform—in addition to verification tasks—other duties of civil earth observation, which are of great importance. Earth observation seems to me—as I stated earlier—to be one of the most important tasks for the future, particularly in terms of the environment.

### Sesa Italia To Develop Data Processing System for Ariane 5

*90MI0053 Rome AIR PRESS in Italian 27 Oct 89 p 2027*

[Excerpts] SEP [Societe Europeenne de Propulsion] has commissioned Sesa Italia to develop a system for the acquisition and processing of data for the Ariane 5. The ETNA 5 system (Exploitation of Tests for Numerical Treatment Ariane 5) will analyze the tests of the Vulcain engine components to reduce any component defects to the minimum. [Passage omitted] This will allow the engine's production time to be reduced while guaranteeing quality at the same time. Sesa Italia, along with Cap Gemini Geda and Cap Gemini Sogeti, represent the most important European group of professional services for computers and telecommunications in Italy. The development of this system will allow technicians on the Ariane 5 mission to keep all engine components in check. Measurements of every single part of the engine will be made by taking samples 40,000 times per second. This permits a constant, real-time analysis of even infinitely small irregularities. The samples will be taken by mathematical analysis methods (in modal, acoustical, and signature frequency) and three-dimensional graphic representations of the physical phenomena acquired will be created. The hardware consists of a mini Allian FX/80 supercomputer based on parallel processing, and parallel and vectorial architecture (47.2 Mflips, 64 mBytes of physical memory, Unix/Nfs) controlled by Silicon Graphics Unix workstations. The peripheral equipment includes a Preston A/D convertor, a precision filter, a Thorn EMI magnetic tape, and an Imagen A4 laser printer. The local area network is an Ethernet TCP/IP.

### Italy: Tecnospazio's Space Robotics Activities Described

*90MI0025 Rome SPAZIO INFORMAZIONI in Italian2 Oct 89 pp 4-5*

[Text] The Tecnospazio company, established by FIAR and COMAU, is currently involved in several activities in the field of space robotics. Under the EMATS (Equipment Manipulator and Transportation System) program completed early last summer, Tecnospazio was responsible for the development of manipulators and mechanical and electrical interfaces. The program was led by the German company Dornier under contract with the European Space Agency (ESA) and involved a feasibility study of a robotic system for the Columbus Free Flying Laboratory. ESA, however, has already approved a study contract for the following stage. In addition, the Milan-based company acted as a subcontractor for the Spanish company Sener in the EVA (Extra Vehicular Activity) Robotics Aids program by developing an electric prototype model of a special space wrench for ESA which can be used both by robots and astronauts. The contract for the development of this wrench amounted to approximately ECU 600,000, approximately 200,000 of which were allotted to Tecnospazio's area of responsibility.

As ESA's prime contractor, the Italian company has recently completed the first stage of a feasibility study for the development of a minirobot known as the Sampling Acquisition System, designed to take samples from the nucleus of a comet. This project forms part of the CNSR (Comet Nucleus Sample Return) program for the development of a special probe which is currently under study by the French company Matra. Over the next few days, ESA should sign a contract for the second stage of the feasibility study for the Italian minirobot. This will involve developing the prototype of a section of the mechanical arm and certain pieces of equipment (such as a drill and a simplified model of an anchor system). As for the company's future activities, by the end of this year ESA should award Tecnospazio a contract for the Stereovision project worth approximately ECU 400,000. The project will deal with the study and development of an expert system for the automatic interpretation of images, to be used in a large number of space missions. The contract, which will also be awarded to the French company SAGEM [Society for General Applications of Electricity and Mechanics], will focus on developing a prototype of this expert system. Tecnospazio's future programs include a feasibility study of critical components for space robotics and the development—as a subcontractor for the Netherlands company Fokker Space & Systems—of the robotic arm for the European space shuttle, Hermes.

## AUTOMOTIVE INDUSTRY

### FRG, UK Innovations in Fuel, Electronic Systems Detailed

#### "Bio-Diesel" Tested

*90CW0034 Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 9 Oct 1989 p 10*

[Article: "Rape Seed Oil Diesel for Production Engines - Extended Driving Tests Under Way/ Refinery Built"]

[Text] The Society for Development Technology (GET), Aldenhoven, has developed a method with which rape

seed oil can supposedly be converted to a diesel fuel. This fuel can then be used directly in commercially available production engines. The product, called Bio-Diesel, is currently undergoing an extensive driving test. As reported, bench tests conducted by the automobile manufacturer BMW AG, Munich, and by the Technical Inspection Service Rhineland (TV) resulted in markedly lower exhaust emissions. It is further reported that the Bio-Diesel produces fewer hydrocarbons, carbon monoxide and nitrogen oxides and that particle emission is reduced by one third.

Rape is an important factor in the production of fuels from reproductive raw materials. Rape is a grain from the crucifer family whose seeds have an oil content of more than 40 percent. This oil is a desirable raw material which is used, for instance, for the production of lubricants. For the production of Bio-Diesel, the rape seeds are de-oiled on a worm extruder.

However, this oil is not suitable for use as a fuel in commercially available production engines, because it has a high viscosity and contains a considerable amount of natural impurities. Therefore, the oil is processed chemically, deacified and freed from slime in a technical installation called agro-refinery and developed by GET.

The essential step in this process is an ester interchange. The natural fatty acid esters contain glycerin, a trihydric alcohol, which is exchanged against methanol, a monohydric alcohol. The resulting methyl esters which have a markedly lower viscosity undergo two cleaning processes and can subsequently be used as a fuel. The released glycerin is separated from the solution and sold separately. GET co-owner Dr. Klaus Scharmer estimates that in the Federal Republic, rape is grown on approximately 1.8 million acres of agricultural land with each acre potentially yielding about .6 tons of Bio-Diesel.

A production installation such as the agro-refinery producing approximately 15,000 tons of Bio-Diesel per year costs about DM20 million. According to GET, it costs about DM1.10 to produce one liter of Bio-Diesel. This calculation assumes that Bio-Diesel will not be subject to the mineral oil tax. Another cost factor is the processing allowance with which the European Community subsidizes the processing of expensive rape from EC countries to compensate for the fact that rape is offered at a lower price on the world market.

## Steering Control Described

*90CW0034 Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 24 Oct 1989 p 8*

[Article: "System for Automobile Electronics"]

[Text] Siemens Kraftfahrzeug Elektronik Nrnberg (KEN) has developed a universal application system for designers of electronic control systems. According to Siemens AG, Munich/Berlin, the parameters, characteristic curves and performance characteristics to be used for the design of a controller could be preset and/or changed. At the same time, the application system saves the values which the controller measured and calculated. As Siemens reports, the system can be universally used for various controlling applications, such as ABS, chassis, motor management and transmissions made by different manufacturers. It can also be flexibly adapted to existing systems. The Siemens device consists of the interface for connection to the control unit and the terminal as a display unit and control panel. The interface consists basically of a special function Eprom simulator. According to the company, any personal computer with an MS-DOS operating system can be used as a terminal.

## Catalytic Ignition

*90CW0034 Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 12 Oct 1989 p 8*

[Article: "Catalytic Ignition for Improved Combustion - British Researchers Present a New Engine Concept"]

[Text] An innovative engine concept which is supposed to work without spark plugs and injection pumps seems to become reality. The engine can be used with any unleaded fuel without causing engine knock and will even reduce carbon dioxide emission by 50 percent. This would pretty much meet the requirements of the pending regulations for carbon dioxide emissions.

The key to these promising improvements is the use of a method called "catalytic ignition." It uses a catalytic converter made of platinum in the engine's combustion chamber. With this converter, conventional spark plugs are no longer required; it also provides for more complete and even combustion than current engines.

For a precise control of this process, the atomized fuel is processed and kept available in some type of prechamber chamber and is pushed into the combustion chamber just before combustion. The prechamber is filled without high-pressure pumps by an electronically controlled injection device.

This new process has several significant advantages. There is almost complete combustion. The combustion temperature is considerably lower, and at the same time substantially faster than in current engines. Since the catalytic converter covers the whole combustion chamber, there is no formation of flame lines which propagate at different speeds. This means that such an engine could tolerate higher rotational speeds.

Moreover, the mixture can be adapted more easily to different loads. The lower combustion temperatures will make it easier for designers to use economical materials; it will also reduce the need for cooling. The concept of achieving better fuel utilization by using separate prechambers is not new. It has been used for a long time, in particular for Diesel engines. However, so far it has not yet been designed as a separate piston system.

As of now, no engine built according to this design is on the test stand. However, the inventors at the British Polytechnical Institute Coventry (West Midlands CV1 5BF, U.K.) can prove the feasibility and functioning of their system based on calculations and experiments. At present, they are negotiating with several car manufacturers, particularly in Japan.

## Spain: SEAT President on Status, Competitiveness

*90CW0048 Stuttgart VDI NACHRICHTEN in German 20 Oct 89 p 14*

[Interview with Antonio Dias Alvarez, president of the Spanish-FRG auto manufacturer SEAT, by Lothar Behr, date and place not given: "We Could Not Have Found a Better Partner: SEAT Satisfied With VW As Parent Company"; first paragraph is VDI NACHRICHTEN introduction]

[Text] Barcelona—Spain is well on its way toward becoming the most important location in Europe for the auto industry. Threatened with bankruptcy only 4 years ago, as a VW subsidiary SEAT has developed into a respectable firm. SEAT president Antonio Dias Alvarez outlined the current status of the firm for VDI NACHRICHTEN.

VDI NACHRICHTEN: Mr President, in your opinion, what have been the most significant events of the last few years?

*Alvarez:* A great deal has happened, and the current SEAT is no longer the same company it was 4 years ago. SEAT was a business in the hands of the Spanish government with an extremely uncertain future. At that time, we were struggling not only for the company's continued existence but also for a solution.

Since our cooperation with Volkswagen began, we have—I believe—been on the right track. In 1985 we also started exporting; those were humble beginnings. And the quality of our products left much to be desired, not to mention the firm's balance sheet.

Today we are 75 percent held by Volkswagen, and by the end of 1990, we are to be 100 percent held by VW.

Along with Audi, we are the third trademark in the VW group, and, from what we hear, Wolfsburg is quite satisfied with us; and, finally, in 1988 we sold more than a half million cars. As you can see, we have clearly grown faster than either Audi or Volkswagen.

VDI NACHRICHTEN: VW has now assigned a very special role to SEAT. You are, in fact, to take care of the southern European market. Are you truly happy with this very specific role?

*Alvarez:* Why not? It seems reasonable that we would specifically service markets such as Spain, Portugal, France, and Italy, which have always been—so to speak—blank areas in the VW map. Our entry into these markets has been clearly successful thanks to our high quality.

We have more than doubled productivity in our plants. Our plan for the next 10 years is in place, and I believe we will have a significant voice in the European auto industry in the future.

VDI NACHRICHTEN: Four years ago, after your divorce from Fiat, you were looking for a new bride, which you obviously found in VW. A question of conscience: Is it a happy marriage?

### The Break-Even Point Should Be Reached by 1992

*Alvarez:* I have repeatedly stressed that we could have found no better partner. We have been provided for in such a way that today we are in excellent shape. Such a financial takeover is, in my opinion, not a question of happiness or unhappiness. VW gave us a chance for survival—which we have taken full advantage of.

VDI NACHRICHTEN: Is SEAT more vulnerable than other companies in the sector?

*Alvarez:* I think that we are, since we are younger and, above all, smaller. I am afraid that we would be especially hard hit in the event of an economic downturn.

VDI NACHRICHTEN: Do you have any personal qualms about the historic turning point of 1992?

*Alvarez:* It would certainly be inappropriate for me not to think about it at all. However, I am sure that we will have reached the break-even point by that time and will, therefore, be able to withstand increased competition.

VDI NACHRICHTEN: This year you expect to sell 18,000 SEAT cars on the FRG market. How important do you actually consider the FRG market?

*Alvarez:* This year we hope to sell more than a half million passenger cars. In terms of profitability, Germany is, to be sure, not the largest market; we hope—as you said—to sell approximately 18,000 cars. But, if you consider Germany as a test market, it is the most important in the whole world.

You see, the Germans, more than any other buyers, demand quality, not to mention technological demands. Germany is for us a kind of challenge. The word has been out for a long time that if a car is accepted in Germany, it will be accepted throughout the world. And SEAT is accepted, as you can see from the 18,000 units sold this year.

VDI NACHRICHTEN: Do you have special goals for the FRG market in the foreseeable future?

*Alvarez:* We are working on further expanding our level of recognition and our image in Germany. For this we are also using the resources of innovative advertising, sponsorship, and public relations capabilities. Furthermore, we are expanding our dealer network with the

objective of complete coverage of Germany with the qualifications of our partners taking priority. Currently, we have just over 400 dealers; our goal is in the neighborhood of 750.

As for our sales figures, our growth rate has been at the top for 2 years now. The high investments of approximately DM10 million over the next 10 years will increase our competitiveness so that there is not just an opportunity to outstrip the individual makes of the Japanese competition in Germany but an obligation. And why shouldn't we be able to ultimately take our place as the leader among the imports?

**We Intend To Define Ourselves As an Independent Make of Car**

VDI NACHRICHTEN: Why don't you want to take advantage of the VAG network of dealerships operating efficiently throughout Europe? After all, doesn't an independent organization cost a lot?

*Alvarez:* To achieve short-term success that would certainly have been worth considering. However, because we want to define and assert ourselves as an independent make of car for the long term, we could not place ourselves in the shadow of the two large makes. In contrast, an independent sales network offers us full potential for development; and we are ambitious enough to take advantage of this.

VDI NACHRICHTEN: Western automakers are whining about the far eastern competition, but you aren't. Are you indifferent to the cars from Japan and Korea?

*Alvarez:* I don't want to be misunderstood on this point. I take the far eastern competition very seriously. I also consider the Japanese who are already manufacturing in the United States and soon will be in Europe as problematic. This is where I see the special problem.

**I Don't Lose Any Sleep Over the Japanese Competition**

As long as the Japanese did their manufacturing in their own country, they had to transport their cars to Europe. Their plants in Europe cause me more concern. However, I don't lose any sleep over the Japanese competition because SEAT belongs to the largest company in Europe, which also ranks as fourth internationally. We can therefore stand up to Japanese competition.

Don't forget: We have highly developed technology with significant development potential. At the beginning of the 1990's, our technology is unquestionably on the cutting edge. In other words: We can keep pace with the Japanese in the area of costs.

VDI NACHRICHTEN: You plan to invest a great deal of money in the future. A new plant is to be constructed in the countryside near Barcelona by 1992. Is Wolfsburg giving you the money?

*Alvarez:* It is obvious that Wolfsburg is not giving us any money. We have established an investment plan, but it is financed from our own funds and, of course, from outside funds. The last balance sheet showed that we have increased our reserves. As we said, we have quite positive results. In 1988, we had no remaining bank debts at all, and this situation made it possible for us to act.

Of course, last year the parent company make it possible to increase our capital so that our investments are completely safe. And in 1990 we intend to increase our capital even more.

VDI NACHRICHTEN: You are building an extremely large new plant while other European firms are complaining about existing overcapacities. Where do you get the nerve for construction of the new facility?

*Alvarez:* It's not a matter of nerve. Our new plant is designed for 1,500 units per day. To be viable in the future, we must have a certain size. At the moment our daily capacity stands at 1,700 units, and the new plant is supposed to replace some production lines so that this cannot be considered overcapacity.

VDI NACHRICHTEN: SEAT currently has three basic models. Can you make a living with that?

*Alvarez:* If you look at our last balance sheet, you will see that it is possible to make a very good living with that. That is also why we don't plan to change anything for the time being. Of course, we have long-term plans to expand the potential of each of these basic models.

We are naturally concentrating special attention on our Ibiza, whose engine we would perhaps like to make even more powerful. We intend in any event to consider that.

VDI NACHRICHTEN: Glasnost is on everyone's lips these days. Do you see any possibility of increased business with socialist countries?

*Alvarez:* So far we have done virtually no business with Eastern bloc countries. We are currently attempting to sell some passenger cars in Hungary.

Since the future unity of Europe is certainly not just theory, it will also be necessary to include the Eastern bloc countries in some form. If you ask me, during the next century it will be necessary to speak more in terms of geographical Europe and not just of Western Europe.

## FACTORY AUTOMATION, ROBOTICS

### Ewab's Just-in-Time System Described

*90CW0052 Landsberg ROBOTER in German Oct 89 pp 42, 44*

[Article: "Basis for Just-in-Time - How Material Flow Systems Support Production"]

[Text] Efforts to synchronize production introduced the time factor into previously rigid material flow systems. However, this resulted in production cycles which need

to be reviewed in the light of increasing mechanization and automation of the manufacturing facilities. Efficiency is no longer determined by the synchronous availability of workpieces at the production stations, but by efficient utilization of costly manufacturing facilities. This is achieved by increasing production versatility and by reducing auxiliary process time during the various processing operations. Such evaluation criteria yield many new production process parameters and result in a capacity review and new requirements for material flow systems. In addition, the frequency of product movement in the companies—today an average of 30 times per year compared to five to ten times previously—increases the demand for suitable material flow systems.

Starting about 1970, the Swedish manufacturer Ewab has been developing material flow systems for this environment which center around transport chains and which include suitable workpiece carriers in addition to control and monitoring elements. The situation is similar to that in handling technology: Standardization based on a modular system is essential for the economic solution of customer-specific requirements. This allows the customer to generate his own facilities layout, the system components can be reused when the facility is changed, and new parts can easily be integrated when the facility is expanded. By now, the Swedes have standardized more than one thousand system components.

Ewab divided the modular system into four main groups, i.e. standardized pallet conveyors, pallets, pallet stations, and control systems. The pallet conveyors act as the actual system link. They are based on a transport chain which runs through a transport base made of steel or light metal and physically connects the production facilities. The different material concept allows transportation of parts weighing more than 400 kg.

The pallets constitute the second main group. Again, this group is subdivided further. Guiding blocks are used for guiding the pallets and carriers as base plates for the pallet structure. The adapters serve again as a mechanical interface to fasten different workpiece-specific structures on the basic pallets. Nest is the term Ewab uses for the workpiece-specific design which takes into account both the different workpieces and process-dependent functions such as manual processing or the immersion of robotic tools. For flexible assembly or processing stations, information can be transported with the workpiece via integrated programmable coding systems.

The pallet stations are again subdivided into robot stations, manual stations and conveyor stations. The manual stations include stations for loading, processing and waste removal. A robot station is a functional unit where processing is done by robots or machines. Since this requires more precise positioning, even in the one hundredth millimeter range, special facilities are provided. The conveyor stations ensure the automatic distribution of the pallets among the transport systems.

The control system is also based on a customer-specific design. To give an example, the control for the Ewab systems PS 800 or CS 900 for workpieces weighing up to 350 kg is designed as a central control with electromechanical and electronic components. The use of coding systems or monitoring functions requires an electronic control. The Swedes, whose company started 20 years ago, count among their customers domestic car manufacturer Volvo as well as manufacturers such as Ford, Austin Rover, BMW, Chrysler, Mercedes-Benz and many other companies from many different industries. With approximately 170 employees, the company has worldwide sales of close to DM33 million. Just under 10 percent of this amount is spent for development annually. The subsidiaries in Switzerland (established in 1974) and Germany (established in 1980) were among the first bridgeheads abroad. Today, Ewab is represented in all Western industrial countries.

## MICROELECTRONICS

### European Electronics Market Expected To Ease

*90AN0093 Chichester INTERNATIONAL TELECOMMUNICATIONS INTELLIGENCE in English 20 Nov 89 p 1*

[Text] The European electronics market grew 4.4 percent in real terms in 1989, according to Elsevier Advanced Technology of Oxford. The market research firm has just published the latest edition of its *Yearbook of World Electronics Data* in which it predicts that 1990 will see a slowing of growth to around 2 percent. But recovery will come in the early 1990s, with an average growth of 5.1 percent a year over the period 1991-93. The total market will be worth $225 billion in 1993.

The fastest growing national market in 1989 was Spain, hitting 7.4 percent, compared with four percent in the UK and 5 percent in Germany. The country looks set to retain a leading position—at least so far as rate of growth is concerned—with a projected growth of 6 percent a year averaged over 1991 to 1993, when the Spanish market will reach $13 billion. Scandinavian countries, with the exception of Finland, are depressed, Elsevier's Philip Rathkey says, with growth well below the European average. Norway, in particular, was badly affected by falling oil prices, and over the period 1987 to 1990 Rathkey estimates its market for electronic products will decrease by 7 percent.

Setting up the single European market scheduled for 1993 will stimulate demand throughout Europe for data processing and telecommunications equipment, Rathkey says. Both sectors will grow by 7 percent a year over the 1991 to 1993 period, with telecommunications "fuelled by the high acquisition of cellular telephones and facsimile terminals."

Total Western European production of electronic products for 1989 Rathkey estimates to be $159 billion, but the total market is worth $193 billion. The most notable

shortfall in meeting its own demands was the UK: her output grew by 18.3 percent in 1989. Consumption, though, leapt by 22.8 percent.

## SGS-Thomson To Build New Chip Plant

*90AN0068 Brussels L'ECHO DE LA BOURSE in French 13 Oct 89 p 3*

[Text] The French-Italian electronic components company SGS-Thomson will build its future chip plant in Crolles, France. The plant and the adjoining research center are part of the Joint European Semiconductor Silicon Initiative (JESSI) program. Investments total Fr 1.3 billion. Two hundred people will be employed at first, and this figure will double by 1996.

The plant will replace a production unit in Grenoble that will be obsolete in 1992.

## Thomson, Siemens, Philips Activities Noted

*90AN0035 Rijswijk PT/ELEKTRONICA-ELEKTROTECHNIEK in Dutch Sep 89 pp 68-71*

[Article by Philip Austin Bosz, chief editor of PT/ ELEKTRONICA-ELEKTROTECHNIEK: "The Story of Three 'DRAMaholics': Memories of the Future at the French 'Componic 89' Fair"]

[Excerpts] [passage omitted]

### SGS-Thomson

As far as SGS-Thomson Microelectronics is concerned, the French electronics giant is determined to challenge Japanese predominance in memory chips and make inroads in the DRAM [dynamic random access memory] market. The company can certainly not be blamed for lack of know-how or capacity, since it is the European leader in CMOS-technology [complementary metal-oxide semiconductor] and 1-Mbit EPROMs [erasable programmable read-only memory] and is already producing 1-micron CMOS technology; moreover, 0.8-micron CMOS prototypes are ready to be launched. These memories of the future have already been developed at SGS-Thomson's Agrate Laboratories in Italy.

These laboratories have recently been equipped with a sophisticated 6-inch VLSI [very large-scale integration] facility, which integrates both a laboratory and a production line and can certainly be considered as one of the most advanced up-to-date systems of its kind. In addition to the imminent 4-Mbit EPROMs, SGS-Thomson is also working very hard on a 16-Mbit version in 0.6-micron technology, which is expected to be ready for production by the end of 1990. Finally, research is soon to be started on the production process for 64-Mbit EPROMs. The knowledge acquired will also be used for the development of lower-capacity EPROMs (256 or 512 kbits) with faster access times, among other things.

Besides its activities in the field of erasable and—to a lesser extent—static memories, the company is determined to make a comeback on the DRAM market, the world's largest semiconductor market, which was worth $6.4 billion last year.

### Siemens

Staff of the West German company's semiconductor division at the Balanstrasse in Munich unanimously condemn the lack of homogeneity within the European market, although they consider it essential to face American as well as Japanese aggression. The solution consists in closer cooperation and, above all, increased R&D spending.

Under the Joint European Submicron Silicon Initiative (JESSI), the Germans are responsible for the development of micron- and submicron-level structured dynamic memory chips, a topic Toshiba has also been working on. Some time ago, the Siemens Regensburg plant produced a 4-Mbit DRAM with a 91-$mm^2$ chip surface integrating some 8.6 million components. Mass production of the 16- and 64-Mbit versions is only a matter of time now. The memory chips are made in 0.9-micron CMOS technology. The techniques used include advanced thin-line lithography using g-line (436 nanometer) wafer steppers and a FOBIC (fully overlapping bitline contact) vertical capacitor cell. The 16-Mbit DRAM in 0.5-micron technology is expected to be ready by the first half of 1991.

### Philips

Philips, the world's largest maker of electronic components and Europe's largest semiconductor manufacturer, relies upon the test production line in its Waalre-based Plant 1 and on its advanced MOS-3 [metal oxide silicon] chip factory in Nijmegen (producing 850 6-inch chip wafers a day) for the development of its 1-Mbit 0.7-micron SRAMs [semirandom access memories]. These are expected to be ready for production in 1991. Production of 256-kbit SRAMs in 0.7-micron technology will start during the first half of next year; the 1-Mbit version is slated to follow 6 months later. The latter has a 128x8-bits architecture and an access time of 35 nanoseconds. The memory chip is manufactured according to the unipolar bimetal [single-poly, double-metal] CMOS process. The chip's surface amounts to 94 $mm^2$, that of a separate cell to 60 square microns. The power requirement is approximately 30 mA at 20 MHz. Four-Mbit (0.5-micron) and 16-Mbit (0.35-micron) SRAMs are due in 1993 and 1996, respectively. Bipolar chips are also being produced in Nijmegen. In anticipation of HDTV [high-definition television], Philips also intends to start producing DRAMs in the near future.

## Philips Announces Japanese CD-I Link-Up

*90AN0108 Brussels L'ECHO DE LA BOURSE in French 2 Nov 89 p 6*

[Article: "Philips Extending CD-I Standards to Video"]

[Text] The Dutch electronics company Philips and the Japanese firms Matsushita and Sony will collaborate on extending interactive compact disc (CD-I) standards to the video field, a Philips spokesman announced.

This extension of CD-I capacities fits into a cooperation agreement announced in May between Philips, Matsushita, and Sony to develop a CD-I standard that will enable their systems to be compatible.

Technical improvement, which is still to be standardized, allows a video image to be obtained across the whole screen, the spokesman added. "Mobile images" on current CD-I systems appear only on part of the screen, which has been heavily criticized by specialists, he indicated.

The updated CD-I standard version is scheduled to be available on the consumer market in 1991.

CD-I provides following services in an interactive and simultaneous way: sound, text, images, video, typing, and storage produced electronically.

## SCIENCE & TECHNOLOGY POLICY

### EC Approves Subsidies for Researchers

*90AN0091 Brussels EUROPE in English 18 Nov 89 p 9*

[Article: "State Aid: 'The European Commission Approves the Dutch Aid Plan For Wage Subsidies in R&D Activities'"]

[Text] The European Commission has approved the Dutch aid plan called "Subsidieregeling Innovatiestimulering (1989)" [Regulations for Funding of Innovation Incentives] aimed at both stimulating R&D activities and at increasing the number of firms engaged in R&D by subsidizing the wage costs of employees in R&D activities. The average aid intensity is 16.2 percent (gross) for firms which fewer than 50 employees, and 13.5 percent (gross) for firms with more than 50 employees. The budget for the first year of the scheme amounts to HFL 170 million (about ECU 73 million). The scheme is mainly intended to stimulate applied R&D activities, although basic research is also eligible.

### EC Committee Approves Framework R&D Program

*90AN0098 Brussels EUROPE in English 27-28 Nov 89 p 14*

[Article: "Economic and Social Committee: Critical Approval of Draft Third Framework Programme for Technological Research and Development"]

[Excerpts] In the presence of Mr Pandolfi, vice president of the European Commission, the Economic and Social Committee (ESC) unanimously adopted a voluminous opinion in favour of the Commission's proposal relating to the 1990-1994 Framework Programme for Technological Research and Development (TR&D), the financial support for which is estimated at ECU 7.7 billion. [passage omitted] As for the financing of the programme, the Committee approves the grant of ECU 7.7 billion, which, along with ECU 3.125 billion for the second programme, constitutes a ceiling of ECU 10.825 billion. Noting that the ECU 5.825 billion for the years 1990-92 corresponds to the ceiling in conformity with the interinstitutional agreement, it hopes for a new interinstitutional agreement after 1992. In this context, and in order to have an indicative ceiling regarding the Community effort in research until the end of the century, the Committee is asking the Commission to evaluate the total amount which will be committed for each financial year (from 1990 to 1994) by indicating the percentage of the Community's total budget and the estimated percentage for the total financing of TR&D by the member states.

As for the six areas of action, the Committee has made the following observations:

1) The need for a close link between EUREKA and the area of information and communication technology, a line of action which is not clearly defined as being able to catch up with the areas covered by Japan and the United States, or rather, constitute a European leadership;

2) The Committee wonders about the balance between the area of information technologies and that of industrial and materials technologies;

3) As for "living science and technology," the need for research regarding the handicapped, the sick and the elderly, is stressed, as well as that for biotechnology and agricultural, agri-food, biomedical and health research;

4) Regarding energy, the Committee calls for a separate analysis of actions concerning energy production and that concerning new procedures, and feels that close links should be maintained with the THERMIE(tab)programme;

5) The actions that the Commission has decided to implement under the terms of human capital and mobility should be organised in the form of concerted actions of those with shared costs. [passage omitted]

### FRG: National, Regional 1990 R&D Budgets Announced

*90MI0037 Bonn TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN in GermanNo 513, 16 Oct 89 pp 7-8*

[Text] On 2 October 1989 the Joint Federal and Land Commission for Educational Planning and Research Funding discussed the 1990 budgets of the research institutes and research funding bodies jointly financed by the federal government and the Lands. Altogether, the German Research Association (DFG), the Max Planck Society (MPG), and the 13 institutes from the "blue list" that have a service function for research will be granted allocations totaling DM2.2 billion in 1990.

Specifically, the commission has provided for a joint Federal and Land allocation of DM1.15 billion for the German Research Association's 1990 budget. This spells an increase of 5.5 percent over the preceding year. The commission thus went along with the heads of the federal and land governments who, on 29 June 1989, had confirmed their intention to increase the allocation to

the DFG by this amount. The total amount includes DM359 million to fund the special research programs and DM14 million for the Heisenberg Program. The allocation to the DFG's Gottfried Wilhelm Leibniz Program for the Promotion of Advanced Research has been raised from DM24 million to DM30 million. This special program is jointly financed by the federal government and all the Lands in a ratio of 75:25.

The Max Planck Society will receive a joint federal and Land grant of DM942 million in 1990. This represents a 3 percent increase over the previous years. With the funds at its disposal the MPG can continue to build the new Max Planck Institute of Computer Science in Saarbrucken and to establish the new project team on cognitive anthropology in Berlin, among other projects.

In addition the commission recommended an overall grant of DM122 million for the 1990 budgets of the 13 institutes that have a service function for research, which are jointly financed by the federal government and the Lands.

## France's CNES Focuses on Technology

*90AN0031 Paris LE MARCHE DE L'INNOVATION in French 22 Sep 89 p 6*

[Text] The National Center for Space Studies (CNES) is being reorganized and technology is being made the top priority with the setting up of a research and applications department (headed by Jean-Jacques Sussel), the appointment of a science and technology adviser (Rene Pellat), and the creation of a central technical office (headed by Alain Simon).

This "technology focus" will be particularly active in two areas: onboard intelligence and the environment. In the words of CNES President Jacques-Louis Lions, this latter point will become "the main issue of the next 10 years."

The reorganization is accompanied by the launch of "mixed intelligence." This innovative concept is designed to bring about agreement between supporters and opponents of manned flights. The former consider that man is an incomparable "data probe," capable of adapting to any situation. The latter believe that man does not belong in space and that automated systems perform just as well at less risk. To that, Lions replies: "It is unthinkable to entrust space missions solely to automated devices; solutions relying on the use of artificial intelligence and robotics do not appear realistic given current technological conditions." The CNES, which has no laboratory of its own, will thus have to spearhead (and finance) both approaches by intensifying its policy of subcontracting R&D to universities and laboratories.

However, this position of "technology observer" has its disadvantages, as summed up by Sussel: "In Toulouse we have nearly 460 engineers and a huge reservoir of basic technology. But there are problems in maintaining these skills, as we give greater importance to having things done by others. There is a risk that our engineers will become too introverted and will lose contact with the universities or the big technological agencies such as the Atomic Energy Commission (CEA) or the National Office for Aerospace Studies and Research (ONERA). They have to travel to understand what is happening elsewhere. The space sector does not have a monopoly on advanced technology."

Three essential areas of activity are being retained: robotics, artificial intelligence, and assisted vision. The Laboratory for Automation and Systems Analysis (LAAS) of Toulouse should be one of the main beneficiaries of these initiatives.

## Budget Increase for French Industrial Research

*90AN0032 Paris LE MARCHE DE L'INNOVATION in French 29 Sep 89 p 1*

[Article: "R&D A Priority"]

[Text] The Ministry of Research and Technology (MRT) budget for 1990 provides an increase of 19.4 percent for industrial research. Public support from the MRT for industrial research (innovation support, ANVAR [National Agency for the Implementation of Research], Research and Technology Fund [FRT], careers in electronics) will reach Fr 4,964 million next year as compared to Fr 4,156 million in 1989. This spectacular effort (to which must be added those of the other ministries) is designed to compensate for the chronic weakness of French firms. The FRT will get the largest increase (30 percent). These funds (Fr 1,566 million), for the most part distributed to industry, cover the large national programs (materials, biotechnologies), the EUREKA program, and the major innovations (advanced technologies). ANVAR's budget will increase by 10 percent (Fr 845 million) through increasingly greater orientation toward small and medium-sized businesses and an extension of the grant for recruiting researchers. The research tax credit, considered a useful tool and supported by the Gendreau/Cantacuzene report, has also been increased. This year nearly 7,000 firms (for a total of Fr 2,600 million) will use this procedure, designed to stimulate "dormant" R&D firms and sectors. Civil aviation has received a large increase (16.6 percent, to reach Fr 2,882 million), justified by major current and future development and industrialization programs ([Airbus] A330/340, CFM 56-5-C2, development of a large engine, and supersonic and hypersonic aircraft projects). The same is true for space (up 11 percent). Training through research has once more been reinforced, to make up for the worrying deficit France is experiencing in this field. The number of theses funded is to be doubled, and CIFRE agreements will increase (650 in 1990 as compared to 550 in 1988). With all this good news, national R&D expenditures in relation to GNP should reach 2.38 percent next year. At this rate, the much-publicized 3 percent, considered to be the minimum necessary for a country's success, will be reached in 1997.

## COMPUTERS

### GDR Automation Software Design, Development Described

*90CW0036 East BerlinELEKTRIEinGermanNo9,Sep89 pp 337-341*

[Article by W. Kunke, G. Meyer, R. Neumann, R. Waechter, KDT, Karl-Marx-Stadt: "Computer-Aided Design and Implementation of Automation Software"]

[Text] Dr. Werner Kunke (42), engineer, is a lecturer at the Technical University Karl-Marx-Stadt, Section Automation Technology.

Prof. Dr. sc. techn. Gernot Meyer (45) holds a chair for Technical Cybernetics/Control Technology at the Technical University Karl-Marx-Stadt, Section Automation Technology.

Dr. Ralf Neumann (41), engineer, is assistant lecturer at the Technical University Karl-Marx-Stadt, Section Automation Technology.

Prof. Dr. sc. techn. Roland Waechter (55) holds a chair in Automation Technology at the Technical University Karl-Marx-Stadt, Section Automation Technology.

#### 1. Introduction and Objective

The primary tasks involved in basic automation are the control of technical processes and relevant physical parameters as well as system monitoring, diagnosis and communication (Figure 1). An effective solution of automation tasks requires both sophisticated basic equipment and the development of process specific automation software. In addition, tools are required to improve the efficiency of designing the control algorithms and their implementation and for projecting hardware needs. These tools should be designed for a relatively universal application. Below, we describe software tools for computer-aided design of automation software and its implementation which must meet the following requirements:

—ease of use, i.e. use of problem-oriented notational formats, preferably based on graphic descriptive means acceptable to the expert.—transparency—off-line testing (verification)—start-up support (on-line testing).

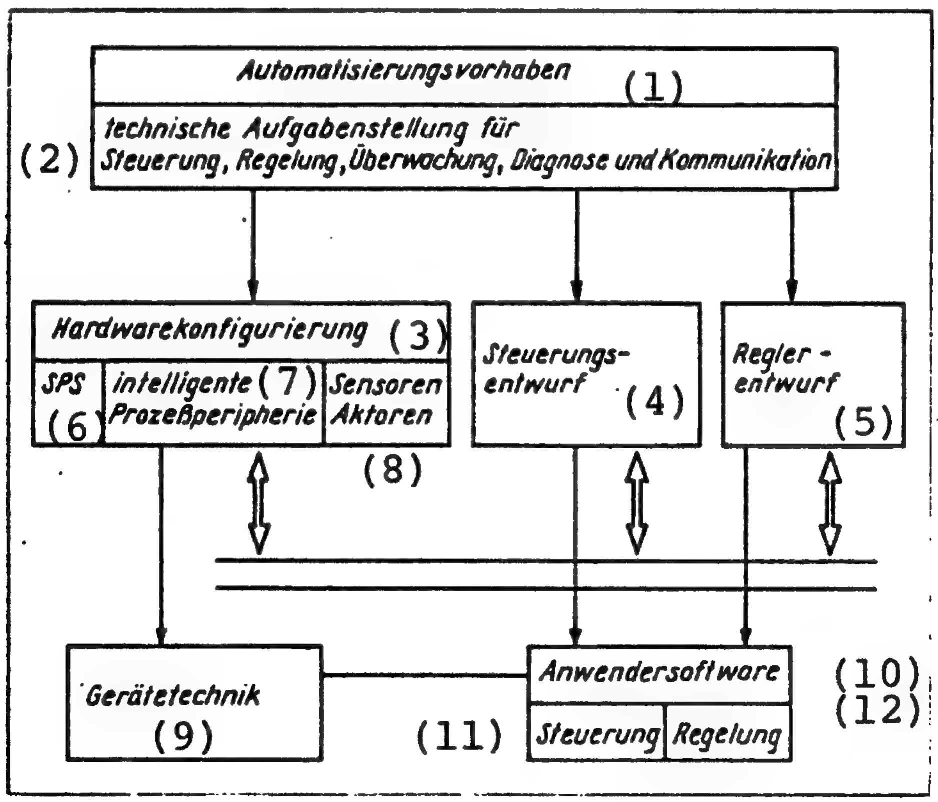


**Figure 1. Design of Automation Facilities**

Key:—1.Automation Project—2.Technical Tasks for Open and Closed Loop Control, Monitoring, Diagnosis and Communication—3.Hardware Configuration—4.Open Loop Control Design—5.Closed Loop Control Design—6.SPS—7.Intelligent Process Peripherals—8.Sensors, Actuators—9.Device Technology—10.Application Software—11.Open Loop Control—12.Closed Loop Control

With the exception of the data exchange required (clearly defined interfaces) and the specific hardware needs which need to be taken into account, the open- and closed-loop control components of automation solutions can be designed fairly independently of each other. This requires a source notation based software system as shown in Figure 2. From it, compilers will generate a code allowing simulation (verification) of the designed structures. Controller simulation usually requires simulation of closed-loop control systems so that temporal, numerical and limit

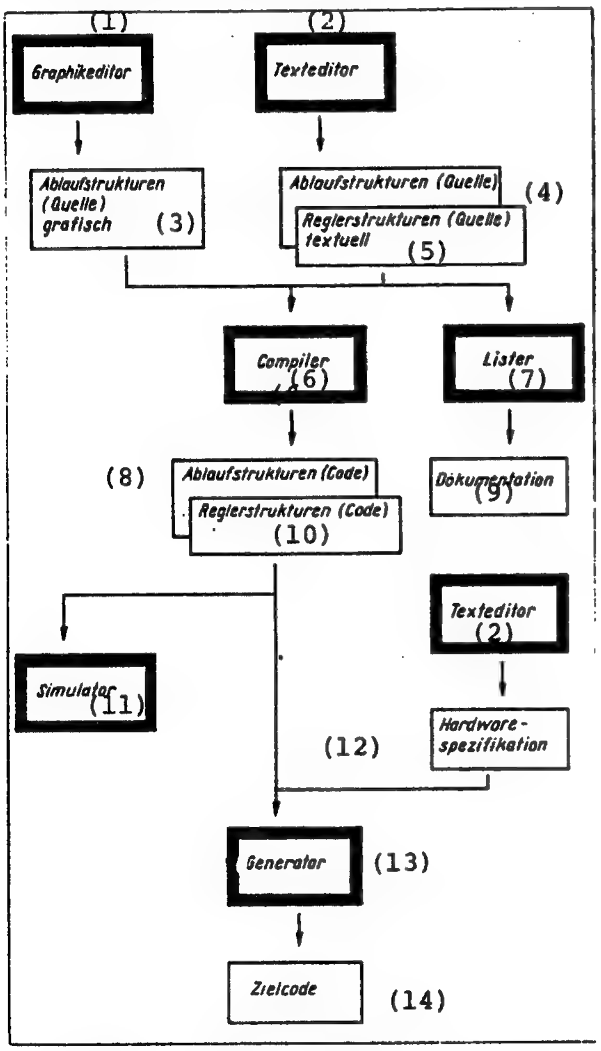


**Figure 2. Development Software Components**

Key:—1. Graphics Editor—2. Text Editor—3. Process Sequences (Source), Graphic—4. Process Sequences (Source), Text—5. Closed Loop Control Sequences (Source), Text—6. Compiler—7. Lister—8. Process Sequences (Code)—9. Documentation—10. Closed Loop Control Sequences Structures Structures (Code)—11. Simulator—12. Hardware Specifications—13. Generator—14. Target Code

effects can also be included. Similarly, for the open loop control algorithms feedback via process inputs can be taken into account by including a process model.

Simulation is followed by actual implementation with a code generator. The code generator generates the target code from the simulation code, i.e. a program which can be loaded into the controller. Not until this final stage of program development does the software design have to include specific control characteristics (operating system, processor type, etc.). This means that the development software described is highly flexible. Adaptation to target controls only requires adapting the code generator.

## 2. Development System for Control Tasks

Control technology usually incorporates processor-oriented descriptive means (list of statements) as well as graphic means of representation such as logic diagrams and contact plan for control programs.

Originally, graphic representation was primarily for the benefit of the control program developers who were used to working with relays. As the automation projects becomes increasingly complex, as control hardware performance increases greatly and more software experience becomes available, this aspect is becoming less important.

Nevertheless, graphic means of description are playing an increasing role as a means of communication among the people who work on automation projects and have no specific knowledge of control functions. Usually, the programmer is given a task in verbal form, later on followed by tables, automatic graphs, pseudocode, Nassi-Shneiderman diagrams or other tools. The programmer transforms this material into a form which is not very transparent and only understandable to him, such as a list of statements or an assembler program. This is already a source of many errors, since the task was either outlined incorrectly or misunderstood because of ambiguous statements, or it was translated incorrectly. A formalized, graphic means of description avoids these communication problems between programmer and customer. In addition, it can be used as program documentation and serves as a useful tool for the technical staff responsible for installing and maintaining the automated facilities. However, this program documentation is only useful if there are no changes during programming. In many cases, planning or construction of the object to be controlled takes place simultaneously with program development. This frequently results in operational changes to the programm tasks which are not properly incorporated into the programming documentation.

Contact and logic plans are not very suitable for more complex automation projects since they are insufficiently transparent. A much more suitable tool is the graphic programming language "Sequential Function Chart", briefly SFC [1], which was proposed in IEC document 65A (Secretariat)-90-I of December 1988. Similar tools are "GRAPH 5" (Siemens) and "GRAFCET" (Telemecanique).

**2.1 Requirements for a Computer-Aided Graphic Design System**

The minimum requirements for such a design system are:

—Graphic representation design is done on screen.—The screen format must not significantly restrict the graphic representations.—It must be possible to print out the graphic representations to avoid time-consuming manual drawing.—Since this is a formalized graphic representation, it must force the user to adhere to the conventions specified.—On the one hand, the design system must be easy to use for beginners, on the other hand, it should not burden the experienced user with unnecessary notes and explanations. Users without any graphics talent must also be able to use the system.—Subdivision of the program into a hierarchy of subprograms must be supported by the editor, to allow for top-down design strategies and to prevent drawing sizes from becoming unmanagable.

The compiler must treat the graphics created like a source file. As shown in Figure 2, the compiler does not generate the target code, but a simulated intermediate code.

PEGASUS is a first version of such a development system. If there is a code generator available for the desired target control, design implementation is automatic. Even if there is no code generator available for the target control, print-out of the verified design kann be left to an SPS specialist.

**2.2 The "PEGASUS" Program System**

PEGASUS is an acronym, derived from the German equivalent for program system for designing by graphic means, for analysis, simulation and translation of control software.

PEGASUS control programs consist of three parts. One part is the graphic representation of control program sequences following standardized SFC representation using steps and transitions. In the program system, such a flowchart is called a control network.

In addition, a specific definition section is required which establishes the variables used, their attributes (input, output, internal) and data types.

The third part of the PEGASUS programs consists of so-called actions and switching conditions. For this purpose, a special user-friendly and text-oriented language was defined. This language follows somewhat the IEC proposal for "structured text". In a planned second version of the PEGASUS program system, this language will follow the IEC proposal more closely. The program system consists of an editor, compiler, connecting unit, simulator, code generator und file service. For calling up components and setting parameters a hierarchical menu system is used. There are help menus with a hierarchy of submenus for all operating functions. Windows make the screen easily readable.

The editor unit consists of 2 editors, the actual graphics editor and a text editor which is used just like "Wordstar". The text editor can be used to generate any type of text file, particularly so-called command files for controlling the connecting unit and sample files with information required for generating the target code (e.g. assignment of the physical I/O addresses to the logic input and output markers in PEGASUS). These files are formal descriptions written in higher-level languages and are required for calling up the connecting unit or the code generator. Connecting unit and code generator can recognize syntax errors in these files. If an error is detected, the text editor is called up automatically, the cursor is placed on the error location, and a brief error message is displayed.

The compiler translates the graphic source into an intermediate internal PEGASUS code. If the compiler detects any errors, it branches automatically to the graphics editor. There, the cursor is placed on the error location and an error message is displayed. If the user works systematically, syntax analyses integrated into the editor will prevent any unpleasant surprises when compiling the program.

It should be mentioned that a pure language version for PEGASUS using a higher-level programming language which can be generated with the text editor is also available. The compiler will process such a text source as well and generate an equivalent intermediate code.

A control network can consist of several subnetworks. Such a subnetwork can contain an independent process sequence, or a partial sequence which is called up from one (or several) other subnetworks.

The network connecting unit combines all subnetworks into the actual control network. However, special subnetworks (so-called auxiliary networks) which are used for test purposes only can also be incorporated. Of particular interest is the option to describe the process to be controlled in an auxiliary network and connect it to the actual control network. In this case, the interaction of control network and process model can be observed using the simulator.

With the simulator, the dynamics of the control network or of individual subnetworks can be examined independently of the control and the process to be controlled. The simulator main menu offers the following functions:

VIEW(tab)is used for display purposes. Items that can be displayed include assignment of variables, step status, actions assigned to the various steps, switchable transitions, advance conditions assigned to the transitions and information on the process sequences.

CHANGE(tab)allows changing the assignment of variables and activating or deactivating steps. TRACE(tab)(tab)is used to limit or to expand the size of the sequence protocol. In addition, interrupt conditions can be set or deleted. EXECUTE(tab)starts the actual simulation process. FILE(tab)(tab)allows saving of the current status

into a file or to recall a situation from a file. OPTION (tab)is used to change option settings.

The lister allows output of the graphic program representation on an Epson compatible dot matrix printer. The process sequences can be printed out in compact form, and the actions assigned to the steps or the advance conditions for the transitions can be printed out as separate lists. On the other hand, the actions can also be printed out as step symbols integrated into the text and the advance conditions as text appearing to the right of the transition. If a graphic representation does not fit the paper size, several sheets are printed which can be glued together afterwards. Footers with a maximum of four lines can be used to include user specific additional information in the documentation.

The lister can also be used to output pure text files.

The code generator translates the intermediate code generated by the compiler or by the connecting unit into the actual program code for the target control. The code generator can be exchanged. Reprogramming the code generator requires at the most 10 percent of the programming effort that was needed for the rest of the program system. Currently, two code generators are available. These code generators generate an MPSS or a STEP 5 source file. A code generator for PROLOG-S is under development.

The file service allows execution of simple operations for managing or maintaining the storage medium.

The PEGASUS program system requires an IBM XT compatible PC with CGA, Hercules or EGA graphics, 512 KByte main memory and either 2 disk drives with 720 KByte each or preferably a hard disk. An Epson compatible dot matrix printer is required for printing out the graphic representations.

A special installation program for adapatation to various monitors (colors, brightness levels, etc.) will be provided.

### 2.3 PEGASUS Graphics Editor

The graphics editor is the main PEGASUS component. The basic graphics editor menu offers the functions set (step, connector, transition), delete (step, connector, transition, branch termination, line, column, (branching (alternative, parallel), complete branch, insert (line, column) and assign name.

Not all of these functions are available all of the time. The basic menu offers only a few of these functions depending on where the graphics cursor is located. The graphics cursor can be moved in any direction with the cursor control keys. These basic functions make it possible to draw and change SFC program structures on screen very quickly. The available functions are selected so that the SFC structures on screen can always be expanded to an SFC compatible structure. This means that it is not possible to draw structures which can be changed into an acceptable SFC structure simply by deleting part of the displayed structure.

Via the block menu larger substructures can be deleted, moved to another position in the program, transferred into a substructure or copied into a file. Substructures stored in a file can also be inserted. Image compression, i.e. moving all structural elements as closely together as possible, is another option. The additional menu makes it possible to call up an integrated text editor, to check the structure just edited for completion, to edit another substructure, to save the edited SFC structure in a file, to call up the PEGASUS compiler and to exit the editor.

The built-in text editor is required for assigning actions to steps and advance conditions to transitions.

The names used for inputs, outputs and marker must also be defined. There are help screens both for operating the editor and for syntax problems. When exiting the text editor, the text just edited is automatically checked for syntax. Any errors will be displayed and a help screen with suggestions for removing this error can be called up.

### 3. Design and Implementation System for Digital Closed-Loop Control Systems

An effective use of the control theory results requires computer support for the complete process starting with process definition to implementation of the special control algorithm.

The following process steps are required for implementing a process control:

—process identification in order to obtain process data suitable as a basis for developing a model—development of a model, i.e. developing a process model suitable for the control design—usually a parametric model—control system design including quality requirements, i.e. determination of the control algorithm including parameter values -control system, control path and control loop simulation to examine static and dynamic behavior—implementation of the control algorithms for the specific device technology—start-up of the process control.

These process design steps (in a more general sense) depend to varying degrees on the equipment on which the algorithms for process-oriented open and closed loop control (target equipment) will be implemented. Process identification should preferably be based on the technology of the target equipment. The program systems for model development, control design, implementation and simulation which support the design process should be able to run on commercially available PCs or on programming devices available to users. Model development and control design are largely independent of the target equipment technology, while implementation and simulation must be based on target equipment technology so that the results meet actual requirements as much as possible.

### 3.1 Program System for the Design of Digital Controls

Figure 5 shows the structure of a system for designing digital controls (DDC-RE) which can be operated in the

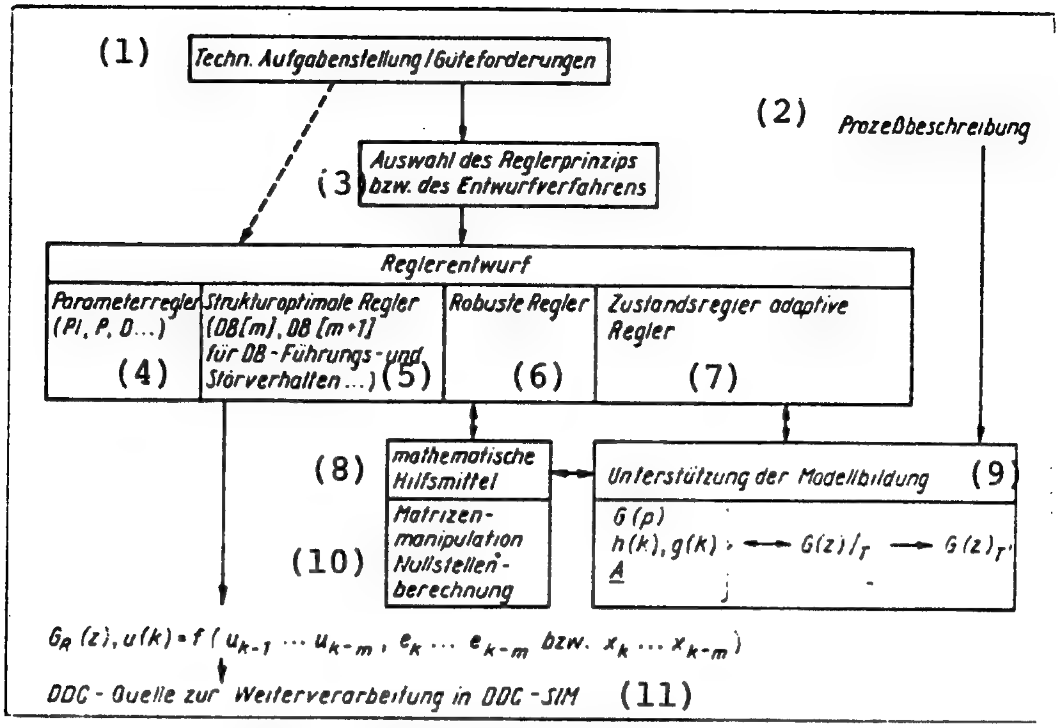


**Figure 3. Organization of the Control System DDC-RE**

Key:—1.Technical Tasks/Quality Requirements—2.Process Description—3.Selection of Control Principle or Design Process—4.Parameter Controller (P1,P,0...)—5. Optimally Designed Controllers (DB[m], D8[m+1] for DB Guide and Interference Situations...—6.Heavy-Duty Controllers—7.Status Control/Adapative Control—8.Mathematical Tools—9.Model Development Support—10.Matrix Manipulation/Zero Point Calculation—11.DDC-Source for Continued Processing in DDC-SIM

interactive mode. In addition to the components of the actual control design, tools for supporting model development are required. Most methods for designing digital controls require knowledge of the z-transfer function of the control system. With DDC-RE, it can be calculated from the continuous transfer function G (p) or from the support values h (k) or g (k) of a transfer function (which could be determined experimentally) or a weighting function or from the system matrix A. The z-transfer function for a certain pulse time can also be calculated from the z-transfer function of another pulse time.

Similar to the use of models for software development, control design program modules use mathematical support programs (matrix manipulation, pole and zero position calculation,...). As a result, the control design provides the z-transfer function $G_R$ (z) of the control or the control equation u (k), i.e. the control difference equation resolved according to the current control value (see also section 3.2).

### 3.2 Program System for Simulating and Implementing Digital Controls

Based on experience with DDC-DIALOG [2], the program system for simulating and implementing digital controls (DDC-SIM) fulfills the following requirements:

—it maintains the concept realized with DDC-DIALOG, i.e. using a program system for simulation and implementation. Simulation is not done as usual (internal step width control, internal sorting of process sequences for integrators, process sequence which does not allow for operator interference with subsequent graphics output, etc.), but as a multilevel real-time program. For the control engineer, this has the advantage that the work process is very visual, that he can interfere at any time, that the real-time program is run the same way during simulation as during the actual process sequence and that therefore the error probability is relatively low when advancing from simulation to implementation. This low error probability applies both to programming errors and to algorithmic errors.

—it maintains the basic structure, on which the DDC-DIALOG is based, i.e. consistent separation of dialog and compiler section, list and table section and exchangeable code generators. This allows implementation of control structures on different processor types as well as simulation with varying numerical precision. Simulating the control with the numerical detected prior to start-up. Thus, DDC-SIM allows simulation in the numerical format of a higher-level

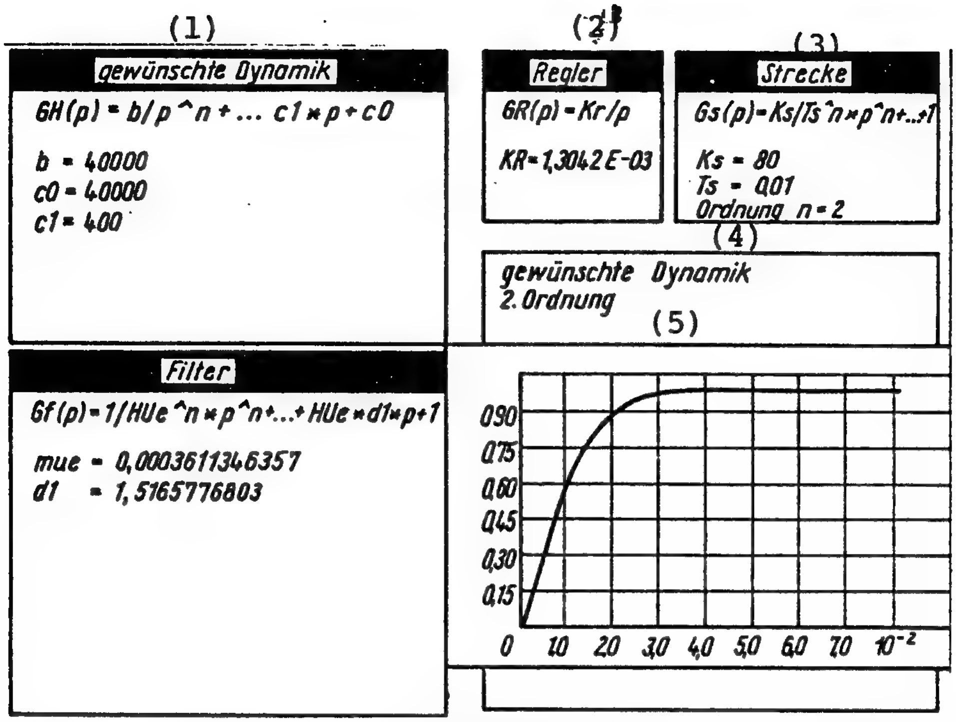


**Figure 6. Possible Applications and Basic Organization of the DDC-SIM System**

Key:—1.Desired Dynamics—2.Controller—3.Distance—4.Order—5.Desired Dynamics of the Second Order

format which is used later in the actual process has the advantage that quantitation and limit effects can be language and generation of application programs for real-time processing. The application programs can be run in simulation using the target numerical format as a real-time program in the generating computer or as a portable program after transfer into a control.

—it uses dialogs and a compiler for determining a control structure to be simulated or implemented. The dialog mode is used primarily for increasing transparency and to make it easier for the user to get started. The use of HELP files and different types of protocol outputs serve the same purpose. A DDC source can be freely generated, e.g. by using a text editor; in addition, a source file can be generated in the dialog mode.

—DDC-SIM has a user-friendly interface to connect to the control design system DDC-RE. One tool is the dialog-driven source code generation by DDC-RE mentioned above, i.e. the control design provides not only the control algorithm (control equation as a transfer function or difference equation or a structure dissolved from the individual transfer elements) with corresponding parameter values, but also a DDC source program. It can be used directly for simulation or later for implementation.

—The following items are suitable for simulation graphics: the output of time functions (see Figure 6), the output of time processes in tabular form, the manipulation (offsetting, change of scale, etc.) of time processes and the display of current values for real-time simulation. Simulation graphics is used both for communication with the simulation section in the higher-level programming language and with the real-time simulation program in the design computer. If permitted by the target device technology, and in particular by the program development level available, simulation graphics should also be used for start-up together with data transfer. Figure 7 summarizes the possible applications explained here.

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1. Kunke, W., Zeidler, S., "Programming of Process Controls," Mikroprozessortechnik 1, 1987, 4, pp 115-117.

2. Neumann, R., "Programming Handbook DDC-DIALOG," TU Karl-Marx-Stadt, Sektion Automatisierungstechnik, March 1980.

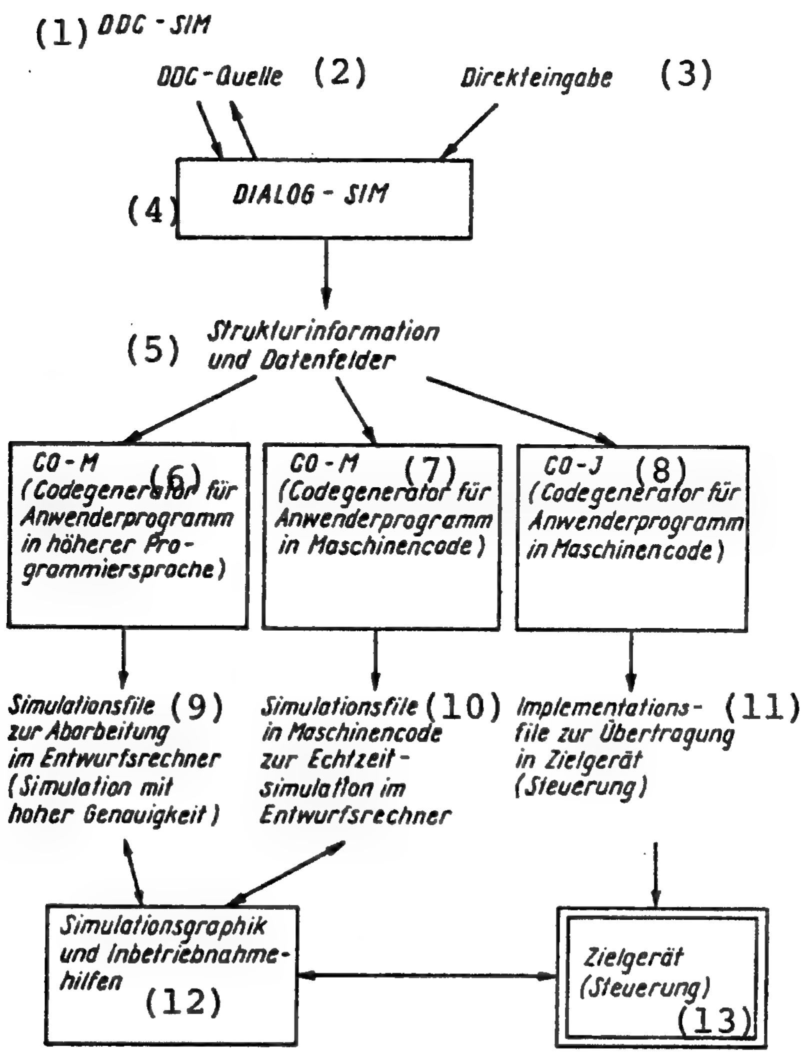



**Figure 7. Design Protocol (Example)**

Key:—1.DDC-SIM—2.DDC-Source—3.Direct Input—4.DIALOG-SIM—5.Organizational Information and Data Fields—6.CO-M (Code Generator for Application Program in Higher-Level Programming Language)—7.CO-M (Codegenerator for Application Program in Machine Code)—8.CO-J (Code Generator for Application Program in Machine Code)—9.Simulation File for Processing in the Design Computer (High-Precision Simulation)—10.Simulation File in Machine Code for Real-Time Simulation in the Design Computer—11.Implementation File for Transfer in the Target Device (Control)—12.Simulation Graphic and Start-Up Tools—13.Target Device (Control)

## FACTORY AUTOMATION, ROBOTICS

### Czech APR 2.5 Modular Robotic System Described

*90CW0037 Brno STROJIRENSKA VYROBA in Slovak No 9, Sep 89 pp 52-59*

[Article by Eng Jan Zan, ScC, Eng Anton Palko, ScC, and Eng Igor Marcin, VUKOV in Presov: "APR 2.5 Modular Robotic System"]

[Text] Discrete processes of production are characterized by a wide range of different operations; at present, their automation depends on utilization of programmable equipment, such as industrial robots, transport devices, production machinery, etc.

Robotized technological complexes (RTK) for partial or complete technological processes may be assembled from suitable configurations of such equipment.

The planning of the RTK must focus on economic advantages required by future users as well as on optimum design.

The current development proves this may be efficiently achieved by consistent applications of modularity and building-block structures in the greatest possible number of technical components of the RTK structure, while adhering to the principle of their mechanical, power and information compatibility.

The advantages of modularity are evident from several aspects:

—Development of specifically designed equipment with optimum technical and economic parameters;

—Creation of new kinematic structures by relatively simple rearrangements of the modules, which makes it possible to approach the performance of new technical tasks in a simple and flexible manner;

—Greater reliability, assuming that prototypes of these modules have been adequately tested;

—Lower costs of production, maintenance and service due to fewer components and units.

The concept of modularity was applied in the design of the APR 2.5 robotic system which is now manufactured by the VUKOV State Enterprise in Presov.

**Structure and Technical Characteristics of the System**

The modular structure of the APR 2.5 system may be divided into four hierarchical categories (Figure 1).

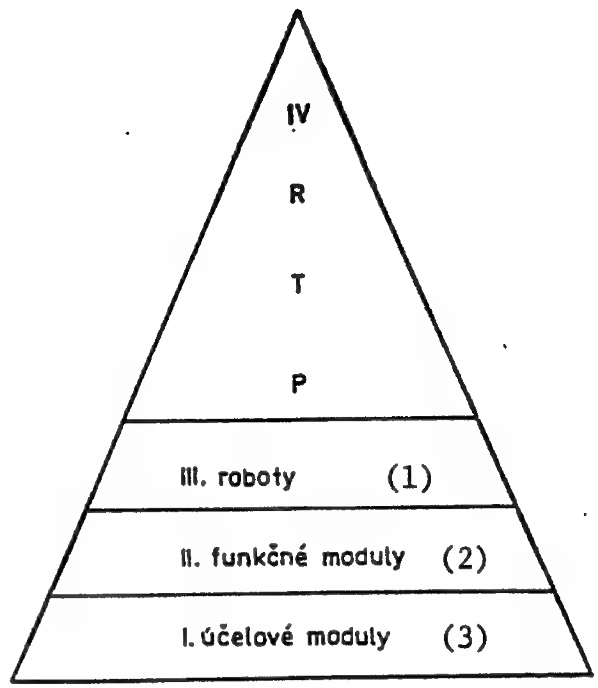



**Figure 1. Hierarchic Structure of an APR 2.5 System**

Key:—1. III. Robots—2. II. Functional modules—3. I. Special-purpose modules

Category I—Special-purpose modules which are components of the lowest category and fulfill elementary functions, include the following:

—Switching modules for input of power into information and movable elements of higher-level modules;

—Mechanical interface;

—Work tables, etc.

The main purpose of these modules is to create higher categories of modules; therefore, it is presumed that they are used autonomously.

Category II—Functional modules as base components of the modular structure perform simple operational and technical tasks.

This category of modules includes:

a) Linear and rotary modules whose basic drive unit consists of a unidirectional disc drive equipped with a tachogenerator measuring the velocity and with an incremental scanner measuring the position. The drive is connected with a converter set so as to enable either linear or rotary movements of the active element of the module (pole, cart, rotary plate). Functional modules are divided vertically according to their maximum capacity, namely, 90, 40, 10 and 5 kg. Every standard horizontal dimension is characterized by the range of movement. Linear modules still have standard dimensions in the range of 100, 300, 400, 1,500 and 3,000 mm, while the range of movement of rotary modules is 90 degrees (1.57 rad); 180 degrees (3.14 rad); and 300 degrees (5.25 rad).

Of a special type are linear modules which permit, in addition to primary movements, also rotary hinge movements for the orientation of the last element in space. The basic design of the hinge permits two kinds of movement—tilting and rotation. Six different variations of hinges with electric servodrive may be achieved by combinations and eliminations of such movements. Modules with bivalent pneumatic drives are available for less demanding tasks.

Technical data on the currently manufactured functional modules are presented in Table 1; Figure 2 illustrates an example of a catalogue page offering functional modules.

**Table 1. Parameters of Functional Modules**

| | Type of module | EML-003/ 0400 SR | PML-005/ 0100 | EML-010/ 0400 | EML-040/ 0300 | EML-090/ 5500 | EMR-005/ 0180 | EMR-090/ 0300 |
|---|---|---|---|---|---|---|---|---|
| Parameter | | | | | | | | |
| Lifting capacity | (kg) | 5 | 5 | 10 | 40 | 90 | 5 | 90 |
| Maximum path of movement | [m] | 0.4 | 0.1 | 0.4 | 0.3 | 1.5 (3) | | |
| | [rad] | S = 3.4 R = 6.1 | | | | | 3.14 | 5.23 |
| Velocity of movement | [$ms^{-1}$] | 1 | 0.2 | 1 | 0.8 | 1.2 | | |
| | [$rads^{-1}$] | S = 2 R = 2.3 | | | | | 3.14 | 3.5 |
| Repeated accuracy of positioning | [mm] | +/- 0.03 | +/- 0.02 | +/- 0.03 | +/- 0.03 | +/- 0.03 | | |
| | [rad] | | | | | | +/- 1.75 x $10^{-4}$ | +/- 5 x 26 x $10^{-4}$ |
| Maximum acceleration | [$ms^{-1}$] | 4 | 6 | 4 | 3 | 3.8 | | |
| | [$rads^{-2}$] | S = 8 R = 12 | | | | | 70 | 5 |
| Bulk | [kg] | 38 | 3 | 29 | 40 | 107 | 4 | 90 |

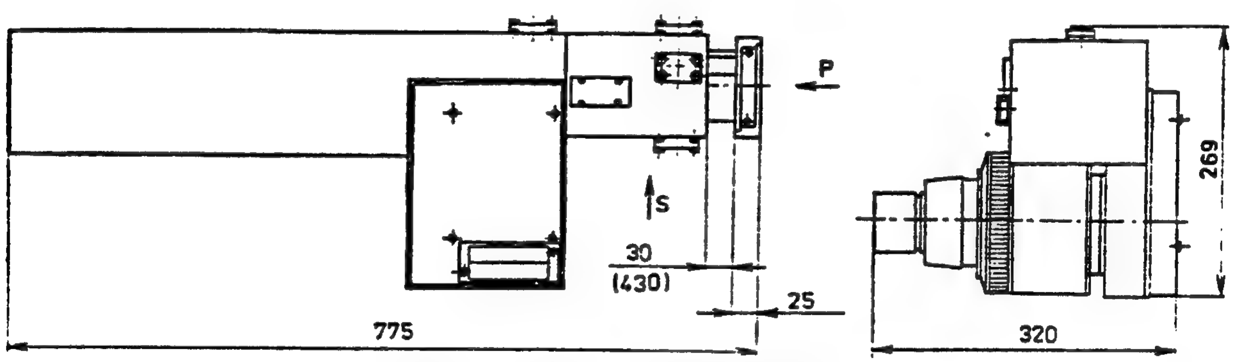



**Figure 2. Linear Module EML-010/0400**

Technical data—Drive: unidirectional electric servodrive; power requirement (kW) 0.35; bulk (kg) 29; maximum lifting capacity (kg) 10; maximum path (m) 0.4; maximum velocity ($ms^{-2}$) 4; repeated accuracy of positioning (mm) +/- 0.03

Key to symbols for type designation:

b) Control modules—this category includes modules which program and control special-purpose modules. Such purposes are currently served by the RS 3A/2.5 control system whose basic construction consists of a RJ 3A/2.5 control unit, a JP-3A/2.5 drive unit, and a stand furnished with a control panel. The design of this system is modular with 2 to 6 control servodrives, an optional control of four discrete axes with a loop check, and two discrete axes without a loop check. A manual control unit (JRR 32) programs the robots by teaching. Programs are stored in a cassette-type unit (KPP 484). Standard 24 input and 24 output signals are reserved for communication with the environment; their number may be expanded by special order to 48. The system can communicate with control computer by means of the communication channel RS 484.

In its standard model the RS-3A/2.5 system is designed as a unicameral frame with an IP 30 electric cover stage. A bicameral RS-3A with an IP 54 cover may be added to its nonstandard model.

c) Technological modules—perform direct technical and control tasks and thus, extend the utility of the system.

To date, the following modules have been developed or are in the final stage of development:

—The R 2.5 system with automatic exchange of grippers, designated for programmed change of grippers and technological heads in the course of operations, which

makes possible manipulations and technical operations with objects of different shapes and dimensions. A pneumatic drive is used to induce the gripping force and the power supply is automatically switched over.

—CHP-2.5-P and CHP-2.5-A model grippers with parallel, or angular jaw movement are designated for manipulation of objects weighing up to 2.5 kg. The grippers are furnished with pneumatic drives.

Furthermore, the following functional models were tested: a screwdriver unit, a pressing unit, a system for automatic pallet change, and a cassette container.

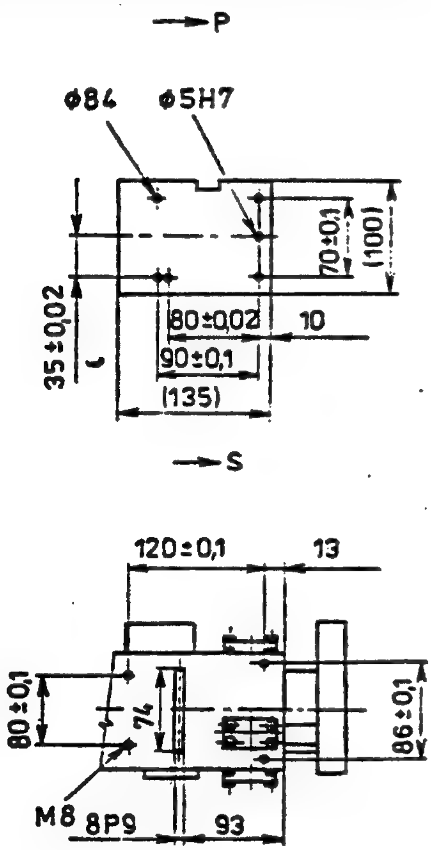



**Figure 2a. Dimensions of Attachment**

Category III—special-purpose robots represent various arrangements of modules of the first and second category.

Their primary purposes are more complex control operations and technical processes. With the assortment of the currently manufactured special-purpose and functional modules it is possible to set up robots with cylindrical and cartesian kinematic structures of stand, portal and bridge models with a latitude of 2 to 5 degrees, and with 3 to 10 kg capacity.

The current production program includes six standard arrangements designated as APE 2.5-01 to 06; their technical characteristics are presented in Figures 3 through 8.

Category IV—Robotic Technological Work Areas (RTP) on the level of higher autonomous units are assembled from modules of the preceding two categories and are capable of automatically performing the entire technological process or its parts. For example, RTP palletization, assemblies, welding, etc., illustrate their potential application in various fields.

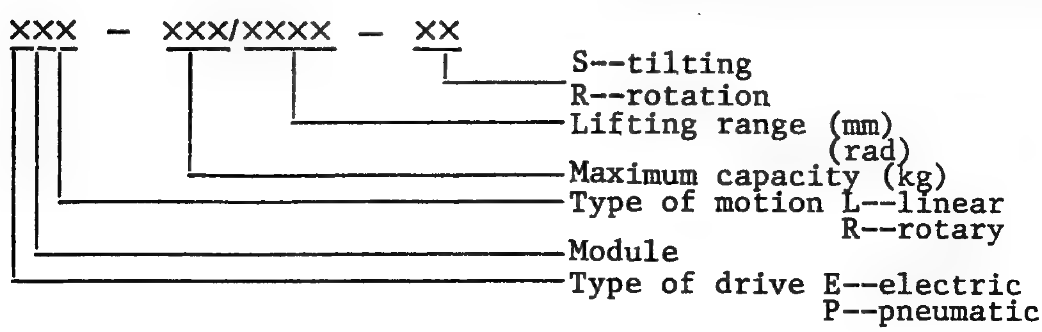
RTP was tested as a prototype for assembly of ball-bearing components.

**Fields of Application**

An open-ended concept of the system is based on the application of principles of strict modularity and building-block assembly structures, facilitating flexible responses to specific demands of the users' sphere. Documentation for the construction of the system is processed in graphic programs on the computer, which makes it possible to select the most suitable model in the shortest time, and to plan its production.

Our intention is to offer the consumer robotic systems that are most efficient and advantageous in terms of technology and economy.

Both their advantageous dynamic properties and their very accurate mobility make the APR 2.5 systems eminently suitable for such sophisticated technologies as



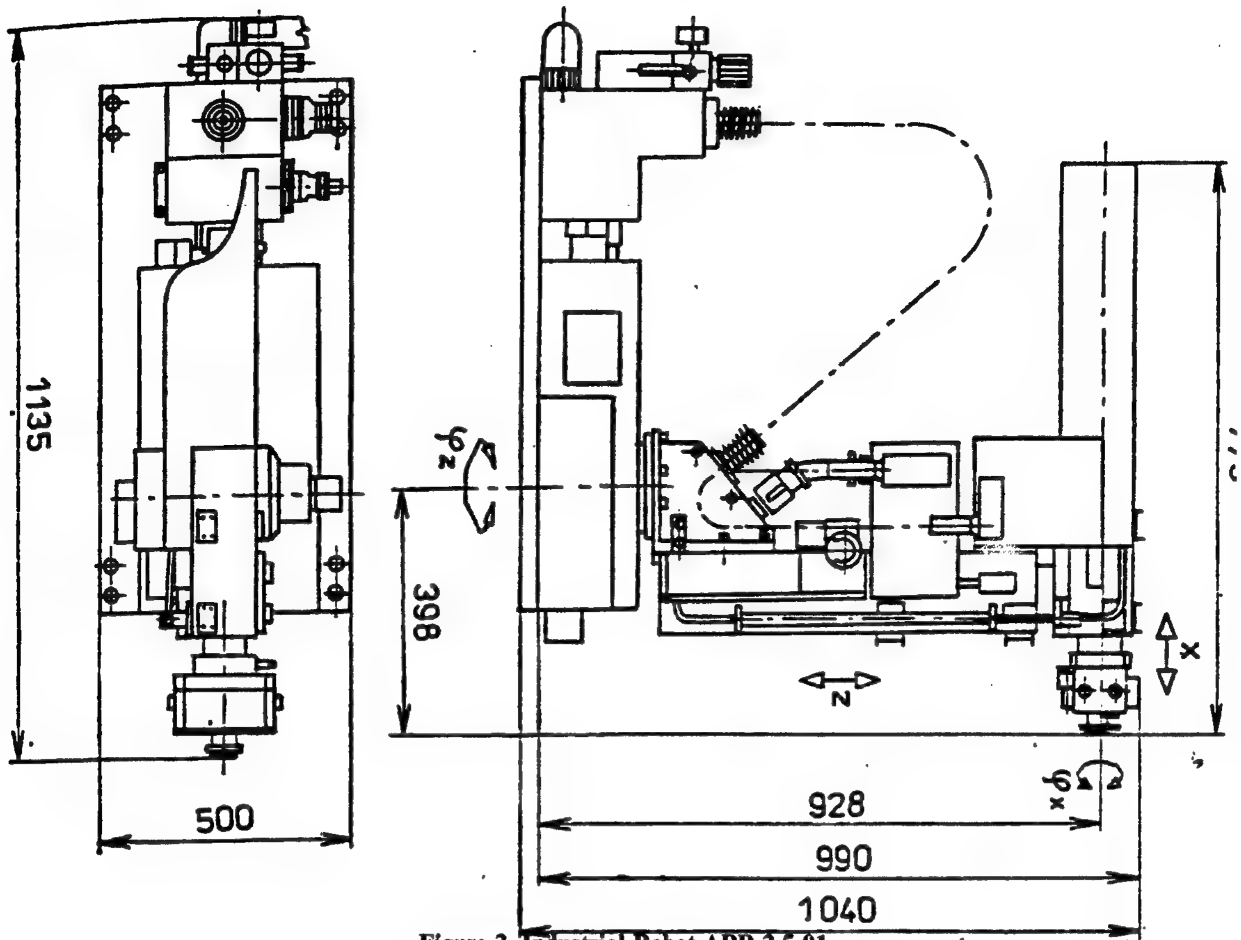



Figure 3. Industrial Robot APR 2.5-01

Technical data—Degrees of clearance: 4 (φ, z, x, φ); type of drive: unilateral servodrives (φ, z, x), pneumatic drive (φ); lifting capacity (kg) 2.5; repeated accuracy of positioning (mm) +/- 0.1; bulk (kg) 120; control system RS 3A/2.5; motion axis φ; velocity 3.5 rads$^{-1}$; x 1 ms$^{-1}$; z 0.8 ms$^{-1}$; φ 1 rads$^{-1}$.

Modules used: PMR-005/0180 rotary module; EML-010/0400 linear module; EML-040/0300 linear module; EMR-090/0300 rotary module; MP 1 switchding module; frame.

a)

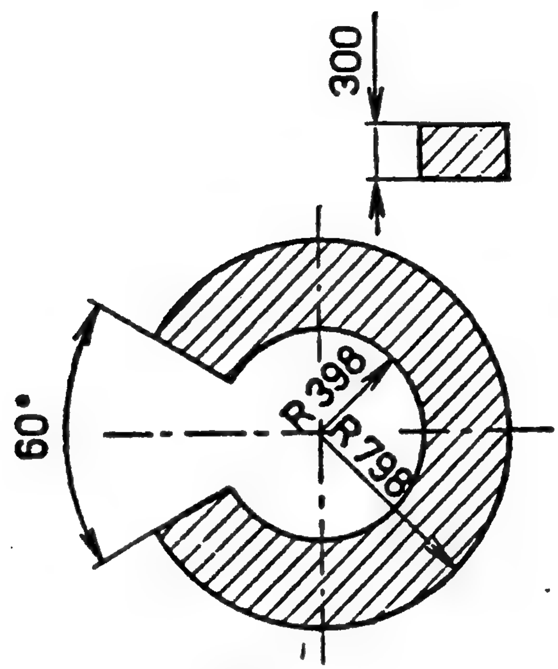



Figure 3a. Area of Operation

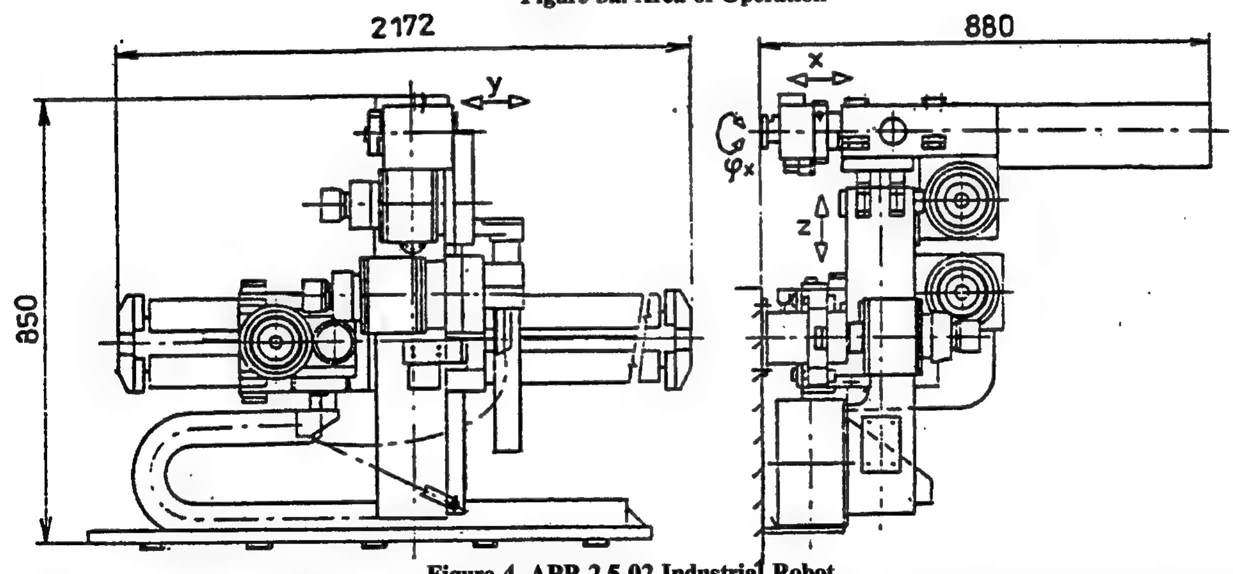



Figure 4. APR 2.5-02 Industrial Robot

Technical data—Degrees of clearance 4 (y, x, z, φ); type of drive: unidirectional electric servodrives (x, z, y); pneumatic drive (φ); lifting capacity (kg) 3.5; repeated accuracy of positioning (mm) +/- 0.05; bulk (kg) 100; control system RS 3A/2.5; movement axis y; velocity 1 $ms^{-1}$; x 1 $ms^{-1}$; z 0.8 $ms^{-1}$; φ 1 $rads^{-1}$

Modules used: PMR-005/0180 rotary module; EML-010/0400 linear module; EML-040/0300 linear module; EML-090/1500 linear module; MP 3 switching module

a)

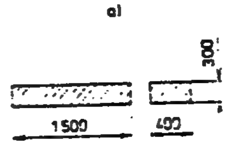



Figure 4a. Area of Operation

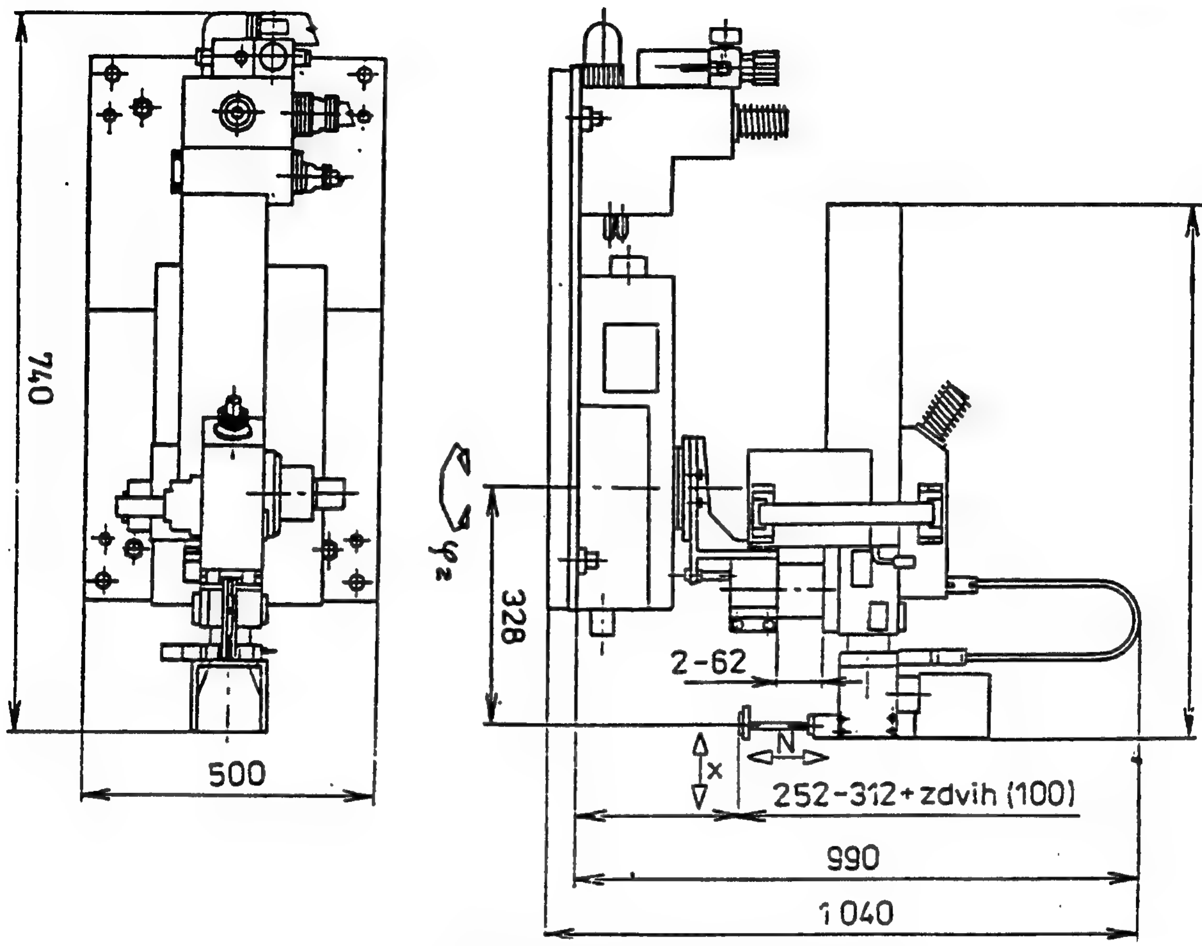



**Figure 5. APR 2.5-03 Industrial Robot**

Technical data: Degrees of clearance 3 (φ, x, z); type of drive: unilateral servodrives (φ, x, z); alternative design for axis z; pneumatic bivalent drive; lifting capacity (kg) 5; repeated accuracy of positioning (mm) +/- 0.1; bulk (kg) 80; control system RS 3A/2.5; movement axis φ velocity 3.5 $rads^{-1}$; x 1 $ms^{-1}$; z 0.2 $ms^{-1}$

Modules used: EML-005/0100 linear module; EML-010/0400 linear module; EML-090/0300 rotary module; MP 4 switching module; frame

a)

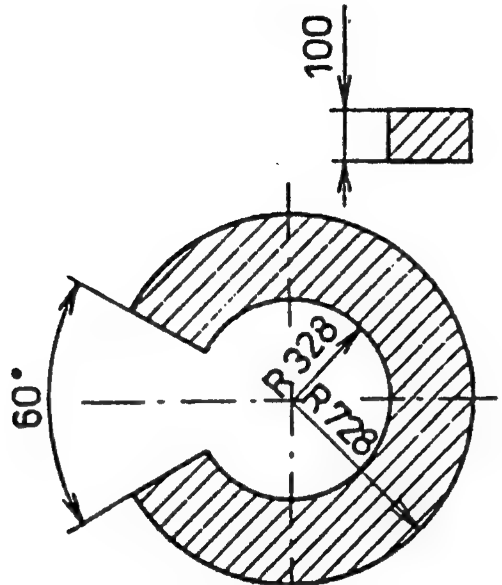



**Figure 5a. Area of Operation**

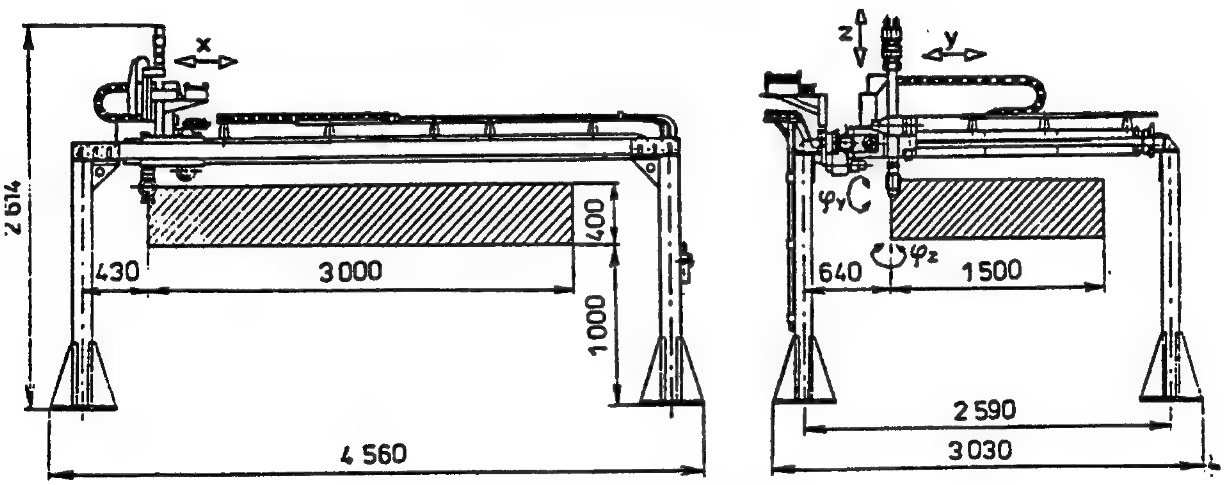



**Figure 6. APR 2.5-04 Industrial Robot**

Modules used: frame; EML-090/3000 linear module; EML-090/1500 linear module; EML-003/0400 SR linear module

Technical data—Degrees of clearance 5 (x, y, z, φ, φ); type of drive: unidirectional electric servodrives; lifting capacity (kg) 5; repeated accuracy of positioning (mm) +/- 0.2; bulk 300; control system RS 3A/2.5; movement axis x velocity 1 $ms^{-1}$, y 1 $ms^{-1}$, φ 2.3 $rads^{-1}$; φ 2 $rads^{-1}$

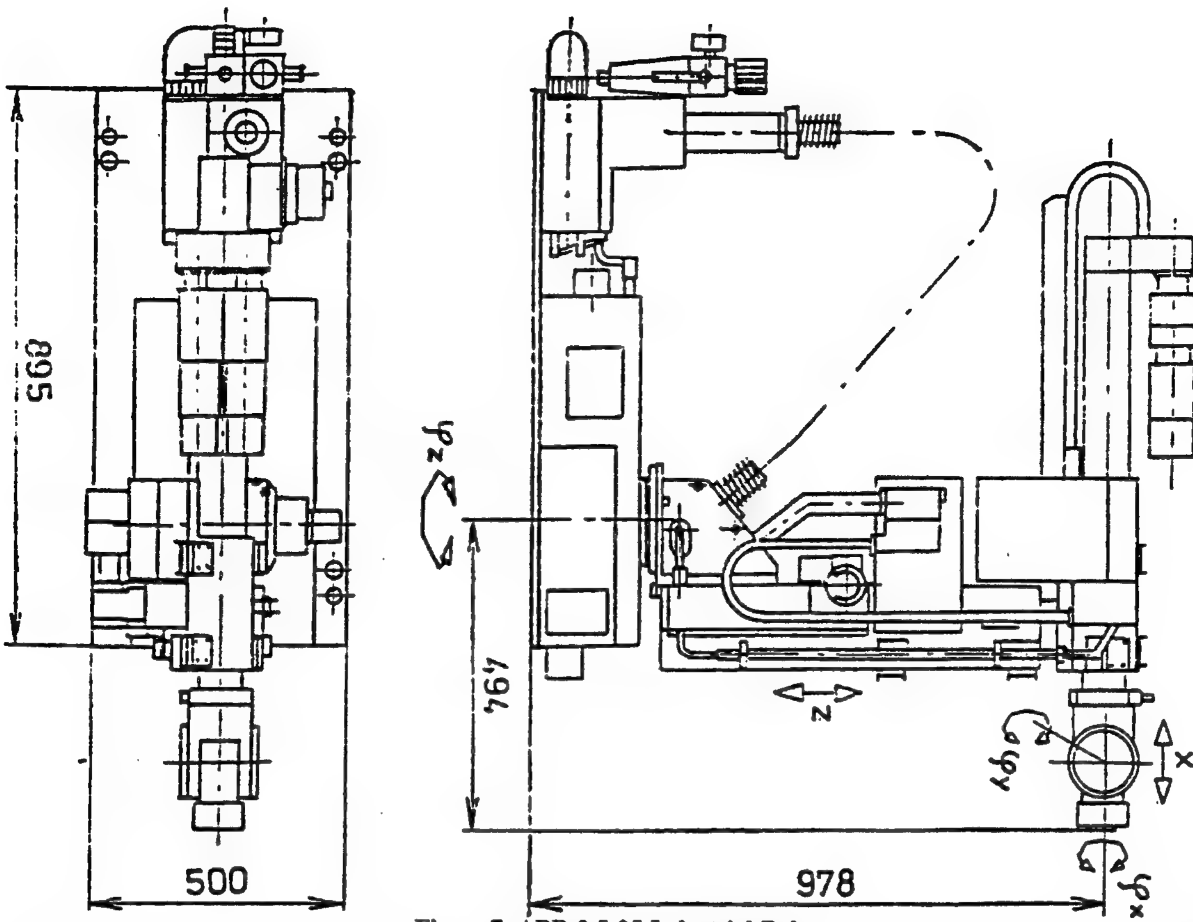



**Figure 7. APR 2.5-05 Industrial Robot**

Technical data—Degrees of clearance 5 (φ, x, φ, φ); type of drive: unidirectional electric servodrives; lifting capacity (kg) 5; repeated accuracy of positioning (mm) +/- 0.1; bulk (kg) 130; control system RS 3A/2.5; movement axis φ velocity 3.5 rads$^{-1}$; x 1 ms$^{-1}$; z 0.8 ms$^{-1}$; φ 2.3 rads$^{-1}$; φ 2 rads$^{-1}$

Modules used: EML-003/0400-SR linear module; EML-040/0300 linear module; EML-090/0300 rotary module; MP 2 switching module; frame

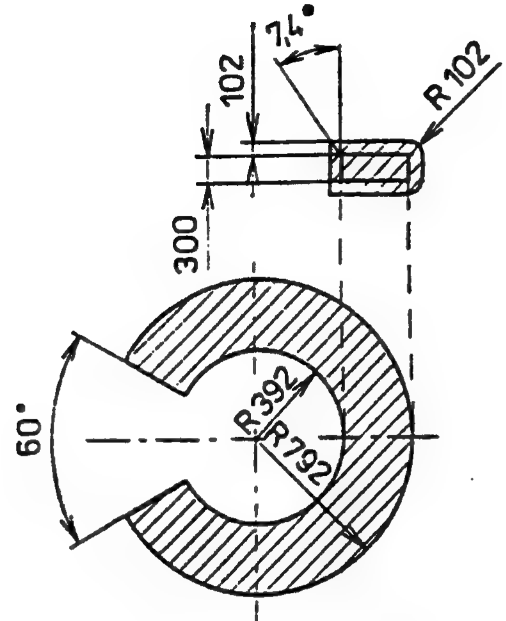



Figure 7a. Area of Operation

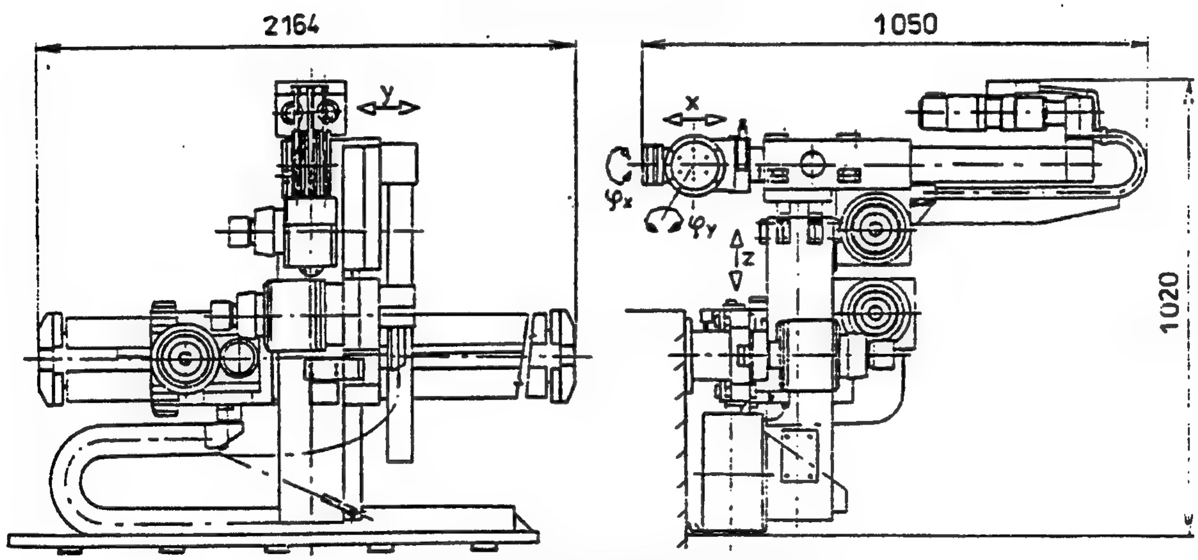



**Figure 8. APR 2.5-06 Industrial Robot**

Technical data—Degrees of clearance 5 (y, x, z, φ, φ); type of drive: unidirectional electric servodrives; lifting capacity (kg) 5; repeated accuracy of positioning (mm) +/- 0.05; bulk (kg) 115; control system RS 3A/2.5; movement axis y velocity 1 $ms^{-1}$; x 1 $ms^{-1}$; z 0.8 $ms^{-1}$; φ 2.3 $rads^{-1}$; φ 2 $rads^{-1}$

Modules used: EML-003/0400 linear module; EML-040/0300-SR linear module; EML-040/0300 linear module; EML-090/1500 linear module; MP 3 switching module

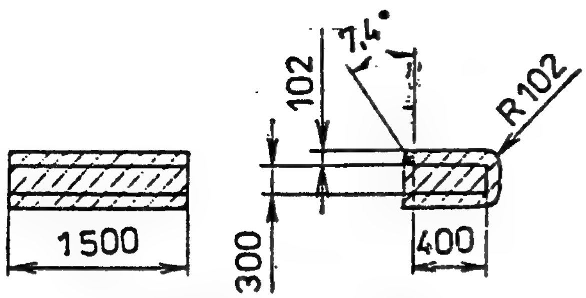



**Figure 8a. Area of Operation**

machine and electrical engineering assemblies, control operations, laser treatment, pressure-water cutting, etc. Figure 9 [omitted in source] presents an example of an APR 2.5-03 used to spread caulking compound on headlight glass of Skoda-Favorit automobiles in the Autopal National Enterprise in Novy Jicin.

In cooperation with our planning department, functional modules of the system may be directly integrated in production facilities, for instance, in machining equipment, textile machinery, presses, etc. Furthermore, it may be presumed that such non-machinery fields as food, textile, shoe-making and leather industries will find many opportunities for APR 2.5 robots, which may prove particularly advantageous for palletization and depalletization, and for the spreading of glue and caulking compounds on various horizontal and spatial surfaces.

Advantageous external dimensions of the robots and their affordable price offer excellent possibilities for their use in teaching of automation techniques in every type of school.

## GDR's Improved IR 20G-3 Industrial Robot Described

*90CW0038A Leipzig GIESSEREITECHNIK in German No 9, 1989 pp 279-282*

[Article by Michael Sidowski, Dietmar Gertz, and Wolfgang Drescher of VEB Metallurgy Installations, Wittstock: "Improved IR 20G-3 Industrial Robot for Foundries"]

[Text] 1. Introduction

Success in using the ZIM 20G and ZIM 20G-1 robots in foundry operations (cf. 1) provided the basis for an improvement in industrial robot technology in this area of application. The collective of VEB Metallurgy Installations, Wittstock, which had already handled preparation and production startup for the ZIM 20G-1 industrial robot, was given the task of implementing the improvement.

The starting point was the ZIM 20G-1 industrial robot presented in (1). The improvements were supposed to incorporate experience gained through use at VEB Light Metal Plant in Rackwitz (LWR) as well as the thoughts and ideas of potential customers, which were the subject of a presentation by Product Group 13, "Light Metal Casting," in Rackwitz (cf. 2). In addition, enterprise-specific aspects had to be taken into account in later production.

Based on these considerations, the following requirements were set out, to be satisfied by the improvements:

- Improvement of the weight-output ratio;
- Increase in axis speed;
- Improvement in serviceability;
- Fitting with safety technology in keeping with TGL 30113;
- Protected positioning and improved tensility of the roller chains;
- Protection of the drive units and electrical wiring from environmental interference;
- Use of proven components in the IR 60-3.

### 2. The IR 20G-3 Industrial Robot

The results of the development work performed were presented in February 1988 with the design worksheets for an industrial robot with 20 kg nominal load capacity and a functional sample of the IR 20G-3 industrial robot.

*2.1. Technical Parameters*

The following technical parameters of the IR 20G-3 industrial robot were established:

| | |
|---|---|
| Degree of freedom | Four freely programmable axes (pivot mount C, lower arm B1, upper arm B2, ladle rotation E); |
| Kinematic structure | Articulated robot—DDD; |
| Nominal load capacity | 20 kg; |
| Repeatability (ladle pouring point) | +/- 1 mm; |
| Total weight | Approx. 900 kg; |
| Drive units (each for (pivot mount (C), lower arm (B1), upper arm (B2), ladle rotation (E)); | Engine: RSM 60-116, gear: WE 160-200; |
| Maximum functional range and speed: | |
| Pivot mount (C) | 330 degrees, υ(max) = 90 degrees/s, |
| Lower arm (B1) | 210 degrees, υ(max) = 90 degrees/s, |
| Upper arm (B2) | 270 degrees, υ(max) = 90 degrees/s, |

| | |
|---|---|
| Degree of freedom | Four freely programmable axes (pivot mount C, lower arm B1, upper arm B2, ladle rotation E); |
| Ladle rotation (E) | 270 degrees, $\upsilon$(max) = 90 degrees/s; |
| Position sensor | IGR 400 X incremental transmitter for all axes (400 increments per revolution); |
| Acceptable temperature range (radiated heat in immediate vicinity of the ladle) | Max. + 840 degrees C; |
| Static weight counterbalance | Balancing weights can be mounted on upper arm (adjustable according to ladle size and average batch size), changeable balancing weight on lower arm; |
| Dimensions of base | 1200 mm diameter; |
| Fastening | 800 x 800 mm, d = 18 mm; |
| Fastening elements | M 16 x 350 stone bolts according to TGL 0-529 or M 16 screws; |
| Operational mode | Continuous operation |
| Protection grade | IP 44; |
| Protection class | I; |
| Use class | +5/+40/+20/90/4101; |
| Control characteristic | PTP, CP (multipoint), LP (linear motion); |

The IR controls have the following parameters:

| | |
|---|---|
| Type of control | IRS 711; |
| Style | Cabinet A acc. to TGL 25080/1; |
| Connection | 3 PEN 380/220 V +10/-15 V, 50 Hz +/-2 Hz; |
| Preliminary fuse protection | 63 A delay-action; |
| Installed load | 9 kW; |
| Average power consumption | Approx. 3 kW; |
| Power share | 4 TDR 100 axis drives; |
| Protection grade acc. to TGL RGW 778 | IP 54 (for IP 21 outside circuit for ventilation); |
| Use class | +5/+40/+20/90/4101; |
| Digital signal inputs | 8; |
| Digital signal outputs | 24; |
| Power supply inputs/outputs | 24 V internal; |
| Serial data interface | IFSS (or V24 standard); |
| User memory | 16 kbyte CMOS-RAM supported (approx. 800 space points with four axes); |
| External memory option | BG 650 cassette tape unit; |
| Programming | Ind. teach-in via BT 700; |
| Speed regulation system | AT 1 tachometer generator |
| Dimensions: | |
| Control cabinet | 660 x 810 x 1932 mm; |
| Command console | 170 x 360 x 40 mm; |
| Control weight | Approx. 450 kg; |
| Command console weight | Approx. 2.5 kg; |
| Cable length of IRS-BT 700 | Approx. 10 m; |
| Cable length of IRS robot | Approx. 15 m. |

### 2.2. General Structure and Function

The IR 20G-3 industrial robot consists of the following main components:

- Mechanical system;
- Control system;
- Measurement and servo system.

The mechanical system features an articulated arm manipulator with a DDD structure. The IR 20G-3 can perform the movements summarized in Table 1.

**Table 1. Types of movement of the IR 20G-3**

| Axis | Axis number | Movement | Result of movement |
|---|---|---|---|
| C | 1 | Rotation | The entire robot rotates around the base |
| B1 | 2 | Forward/back | The lower arm moves |
| B2 | 3 | Up/down | The upper arm moves |
| E | 4 | Incline hand | The ladle moves |

The control system consists of:

- Microprocessor system;
- Memory (RAM and EPROM);
- Digital inputs and outputs for processing the internal robot signals;
- Digital inputs and outputs for the peripheral equipment (freely accessible);
- Logic circuits for controlling the robot's servo system.

The measurement and servo system consists of RSM 60 direct-current engines as well as servo amplifiers like those used for numerically controlled machine tools. Position measurement is done with incremental transmitters followed by logical processing. As a link between the servo system and the mechanical system, special gears that are extremely free of play are used (harmonic drive gears).

The overall control functions for the industrial robot are assumed by a microprocessor system. This consists of a master processor and three slave processors. The master processor coordinates and realizes the control function. Slave processor 1 realizes the positioning functions for the industrial robot. The arithmetic for path control is done by slave processor 2. Slave processor 3 manages any addition input and output.

The basic programs needed for the microprocessor, which ensure the functioning of the industrial robot, are stored in read-only memory (EPROM). The BT 700 command console represents the interface between the user and the control system.

The function of the industrial robot in performing operating sequences is ensured by a working program. This must be formulated and programmed by the user in keeping with the intended operation cycle. To this end, the user must use the TIPS 3 command language (cf. 3) and the BT 700 command console to convey the necessary information and commands to the microprocessor. The working program contains the operational steps that the robot must perform, taking into account input and output signals to and from peripherals. The working program can be conducted by the industrial robot progressively (in test mode) or continuously (in automatic mode) (cf. 4).

### 2.3. Description of the Components

The IR 20G-3 consists of the following components (see Figure 2), some of which are configured as weldings.

2.3.1. Pivot mount (1)

The pivot mount of the IR 20G-3 is the supporting element of the industrial robot. On it is mounted the so-called main bearing. The range of operation is limited by approximation initiators, which are mounted in the main bearing. For mechanical protection, rubber bumpers are attached to the end stops. On the foot plate is a cooling-water valve with a screw connection (three-quarters of an inch). The tubes for feeding in and draining off the cooling water run through the so-called tower cable, which is positioned inside the pivot mount, into the heat exchanger inside the main bearing.

In the swiveling axis of the pivot mount is the drive unit that realizes the manipulator's swiveling motion. It penetrates into the main bearing and can be removed from above.

2.3.2. Main bearing (2)

The main bearing is the central housing component for the manipulator. The main bearing contains the drives for moving the ladle (8), the upper arm (9) and the lower arm (10), as well as the tower distribution plate, which connects the tower cable and the drive units. The drive units are spring-suspended from the front wall of the main bearing. The drive shafts for the upper and lower arms are hollow shafts that are fit into each other and in which the drive shaft for the ladle is positioned. The drive shafts protrude from the outside of the front wall. The lower arm is screwed on at the flange located on the external shaft.

The main bearing is covered by a hood that can be lifted for repair and maintenance. In this hood are a heat exchanger with a blower and a temperature sensor with a switching contact that opens and closes the cooling-water valve and turns the blower off and on.

2.3.3. Lower arm (3)

The lower arm is attached to the flange of the external drive shaft. Using chain wheels, which are pivoted in the middle and upper eye, torque is transmitted through roller chains. These are positioned inside the lower arm. In order to drive the upper arm, a double chain is used, and a single chain is used for the ladle. A spring take-up serves as the chain joint. On the lower part of the arm are

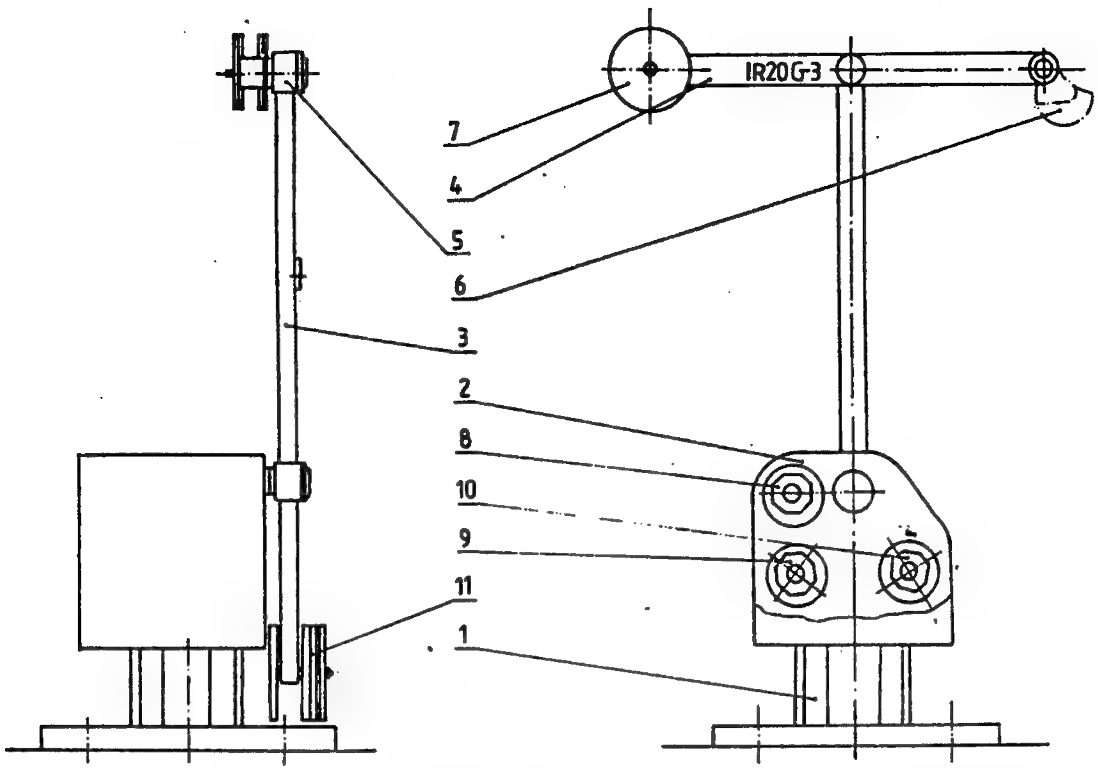



**FIG. 2 Components of the IR 20G-3**

Key:
1. Pivot mount
2. Main bearing
3. Lower arm
4. Upper arm
5. Roller chain
6. Ladle
7. Weight
8. Ladle drive
9. Upper arm drive
10. Lower arm drive
11. Weight

weights (11), attached to a bolt and secured by a nut, which balance out the upper arm/lower arm/load system

2.3.4. Upper arm (4)

The upper arm basically has the same structure as the lower arm. It is screwed on the middle eye to a flange of the lower arm. The shaft that protrudes from this, on which a chain wheel is positioned inside the upper arm, is connected to the chain wheel in the upper eye (5) of the lower arm. This results in a form-locking connection.

By way of a single chain, the torque for the ladle is conveyed to a chain wheel positioned in the front eye. A bevel seat in a drive shaft with dual bearings is used to take up the ladle (6). At the opposite part of the upper arm, there are weights (7), attached to a bolt and secured by a nut, which offset the weight of the part with the ladle.

The industrial robot described here was tested by the manufacturer for 1,000 hours at the testing site and around 150 hours on location at VEB Light Metal Foundry in Bad Langensalza (LGW). Good results were achieved in these tests.

**3. Expansion of Product Line**

At the presentation of Product Group 13 held in Rackwitz (cf. 2), in which the industrial robot's manufacturer enterprise also participated, it was very clear that foundries are generally smaller enterprises without their own production of means of rationalization—in contrast to the output capacity of VEB LWR. This realization has resulted in an expansion of the product line of the industrial robot manufacturer with respect to the IR 20G-3. This expansion relates to two subelements of the system:

- Variations on the IR 20G-3 with optional integration of a removal system;
- Software package for casting die control with the IRS 711 control.

**3.1. IR 20G-3 With Optional Integration of a Removal System**

The user wants to automate the entire process in a casting cell. This includes removing the finished casting from the die. At VEB LWR, a special removal system at each die is used (1). For many foundries, this variation is

too expensive and thus unfeasible. VEB Metallurgy Installations, Wittstock, has responded to this desire by offering the IR 20G-3 in two variations.

In the standard variation, the user has the previously described system at his disposal. In the expanded variation, the IR 20G-3E, a new upper arm is used. This is designed in such a way that a gripper for unloading the casting die can be mounted at its end, opposite from the ladle bearing. This is also manipulated by drive 4 (ladle drive), and thus always moves together with the ladle. Since during the course of the program the industrial robot can begin loading the die only after unloading it, this does not present a problem. In addition, any standstill periods resulting from the technical sequence—for example, solidification time, etc.—can be used to unload more dies. The greatly improved axis speeds are very advantageous here, since they can be utilized for skip movements.

Since the gripper is a very special element, it also seems advantageous to allow the user to make it or have it made for his own purposes. At VEB Metallurgy Installations, Wittstock, however, there are also worksheets for copying a particular gripper configuration. In order to activate the gripper unit, the basic system was expanded with the following two instructions and commands:

Instructions GA, GZ

With these two instructions, the opening (GA) and closing (GZ) of the gripper can be realized in the TI program. The TI instruction following the gripper instruction is processed only after the ready message from the two initiators is received.

Commands GA, GZ

These two commands can be used to activate the gripper when not in automatic mode. The commands are processed immediately after the end of input and are not stored in the TI program. In the event of electrical or mechanical failure at the gripper, the command can be interrupted at any time with CTRL X.

This expansion of the basic software is offered and implemented by the IR manufacturer. This variation of the IR 20G-3 with a gripper has been undergoing tests at VEB LGW since September 1988.

### 3.2. Software Package for Casting Die Control with the IRS 711 Control

When using the IR 20G-3 with IRS 711, there is generally a problem with automatically driving the dies to be loaded. In order to further automate the casting process in die casting, a software module was created that performs the following tasks:

- Free choice of solidification time for the individual dies;
- The individual flues of the dies are opened and closed in a strictly established sequence.

The die functions are controlled through the inputs and outputs in the expansion cassette of the IRS 711 control, independently of the processing of the robot-TI program. Communication between the two parallel processes takes place through a * variable. This process-specific input and output control is realized with slave processor 3 of the IRS 711. In this way, no change in control hardware is necessary.

Handling and programming the die controls is very easy for the user. The necessary steps are limited to setting, resetting, and querying certain * variables in the TI program. In this way, the specific die selection for different dies (solidification time, number of flues) can be specified by TI program. This simplifies work in changing dies.

This software package is also in use at VEB LGW, where it is being tested in a casting cell.

### 4. Summary

The IR 20G-3 industrial robot represents a significant improvement over the ZIM 20G-1 industrial robot. By using the pivot mount of the IR 60-3 and interchangeable drive units for axes 2 through 4, a considerable improvement in serviceability was achieved. Housing the roller chains in the frames of the arms and using a closed covering hood ensures a high level of protection against dust, mechanical damage, and any stray molten metal.

Because of the design change in the mechanical load transmission system, it was possible to achieve higher maximum speeds with the IR 20G-3. In terms of safety features, the IR was equipped with three electromagnetic brakes. This meant that an essential requirement of TGL 30113 was met.

In order to satisfy the desires of users, the IR 20G-3 is offered in two variations (with/without optional integration of removal system). In addition, VEB Metallurgy Installations, Wittstock, offers a software package for casting die control with the IRS 711 control. This expanded product line should cover the increased need for automation in foundries.

Inquiries should be sent to:

VEB Metallurgy Installations, Wittstock, Sales or Technical Customer Service Department, Strasse der DSF 25, Wittstock, 1930.

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## LASERS, SENSORS, OPTICS

### GDR: CAM Applied to Production of High-Powered Photolithographic Objectives

*90CW0067 East Berlin FEINGERAETETECHNIK No 10, Oct 89 pp 444-445*

[Excerpt] Photolithographic projection objectives must meet the highest demands regarding picture quality. In the course of a steady performance enhancement of such optical systems, brightness of definition of way over 90 percent of the total image field and distortion values of a few hundredth of a micrometer were achieved as a matter of computed design. Simultaneously, at the conglomerate, VEB Carl Zeiss JENA, a special combination of production and testing methods was developed for the reproducible production of photolithographic objectives. It extends from the production of optical glass to the correction of the objective.

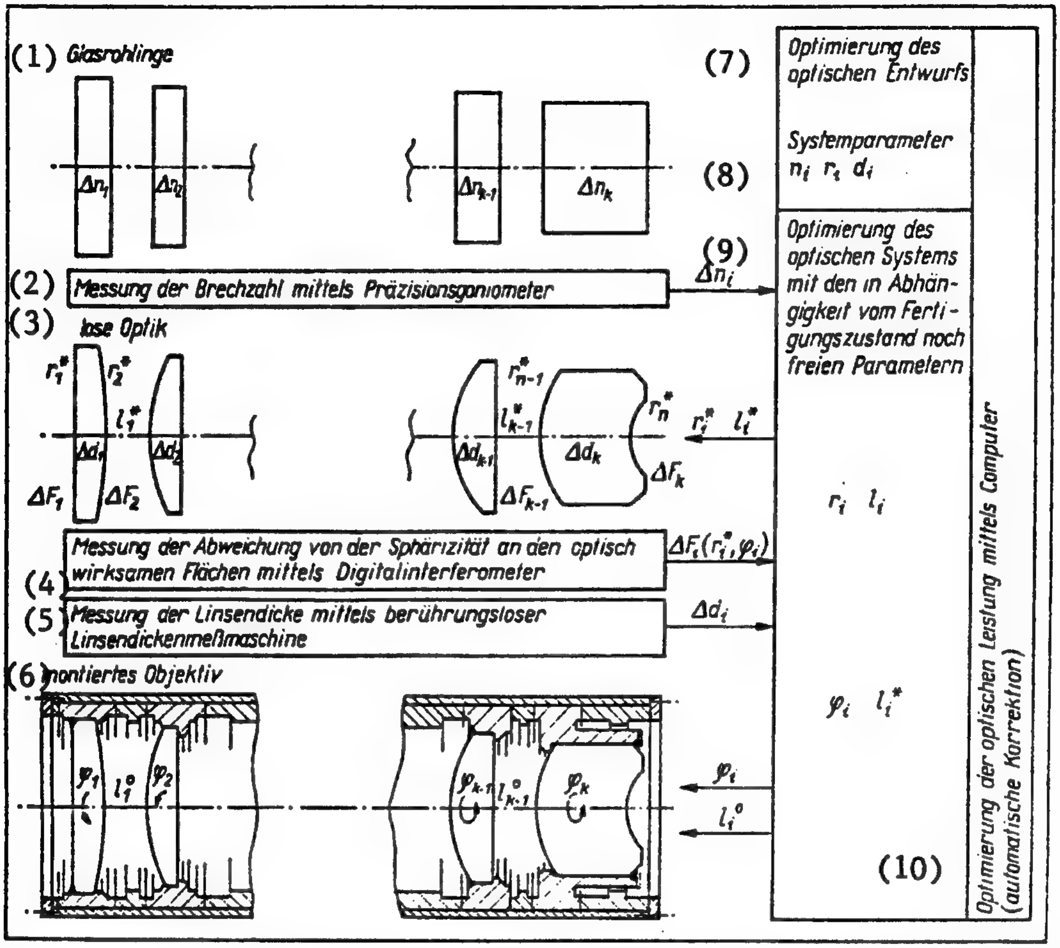
Many years of experience with the production of photolithographic objectives has shown that the correction of a completed objective, be it through externally adjustable correcting elements or through a targeted parameter change in connection with its initial mounting, is always detrimental to the achievable centering stability of the objective. On the other hand, reduction of all production errors to such a narrow range of tolerance that their influence on imaging performance becomes negligible is technically very demanding and leads to very high production costs.

Starting with this insight, a CAD/CAM production concept for photolithographic objectives was developed which stems from the basic idea that the manufacturing error of a production step, for which compensation possibilities exist in the subsequent production step, should be very precisely determined by technical measurement and the magnitude of compensation in the subsequent production step predetermined by means of a modern computer. For all non-compensable production errors, production and testing technologies were developed which consistently guarantee staying within the required narrow limits of tolerance.

This new production concept can be clearly depicted when one considers the formation process of a photolithographic objective (figure 1). Preparation of the optical glasses is the starting point where the tolerance parameters such as refractive index inhomogeneities with large gradients (schlieren), refractive index inhomogeneities with small gradients and the average refractive index are of decisive significance. The homogeneity of classical optical glasses is technologically so well controlled that it is within the detection limits of the most modern interferometric measurement technique (lambda/50) and, therefore, it has a negligible effect on imaging performance. The average refractive index of every round disk which may replace a photolithographic objective is measured with a precision goniometer. The values of the optical design stored in the computer are actualized for every objective through the measured refraction indices. On this basis, an optimization of lens radii is achieved through calculation. The lenses are produced with radii corresponding to the refraction indices.

The external, optically effective geometry of the lenses is exactly measured in the next production step. It can be described in terms of the lens thickness, the average radius of the refracting surfaces and their deviation from exact sphericity (surface deformations). [Figure on p 34]

**Figure 1. Diagram of computer-aided production of high-powered photolithographic objectives**




Key:—1. raw glasses,—2. refractive index measurement with precision goniometer,—3. free optics,—4. measurement of the deviation from sphericity on the optically effective surfaces by means of a digital interferometer,—5. measurement of lens thickness with a lens thickness-measuring machine without direct contact,—6. mounted objective—7. optimization of the optic design,—8. system parameters,—9. optimization of the optical system with parameters which are still independent of the given state of completion,—10. optimization of optical performance by means of a computer (automatic correction)

## MICROELECTRONICS

### Refresh Hardware for GDR's U8820, U8840 Single Chip Microcomputers Described

*90CW0060 East Berlin RADIO FERNSEHEN ELEKTRONIK in German No 10, Oct 89 pp 635-636*

[Article by Olaf Skerl and Wolfram Schmidt: "Dynamic Memories for Single Chip Microcomputers U 8820 and U8840"]

[Text] From the Division for Technical Electronics of the Wilhelm Pieck University in Rostock

This article describes a circuit for the single chip microcomputers U 8820 and U 8840 which makes it possible to operate these microcomputers in conjunction with dynamic memories without taking up time for refresh functions. The circuit also avoids any time conflicts between the refresh process and time-sensitive interrupt operations. The principle used and the refresh hardware circuit will be explained.

Single chip microcomputers are frequently used in measuring technology since their integrated peripheral functions allow a simple set up of computers used for measuring purposes. Some applications require larger memory capacities which can be implemented by using DRAMs. However, DRAMs have the disadvantage that the information stored has to be refreshed at short intervals.

The CPU U 880 provides a hardware support for the refresh function. However, the single chip microcomputers of the U 8810 and U 8820 series require a

complicated DRAM refresh procedure since no refresh function has been implemented and refreshing must therefore be done via software. During one refresh period of approximately 2 ms [1] all memory cells must be refreshed at least once. This process takes up at least 20 percent of the computing time of the single chip microcomputer. In addition, during time sensitive interrupt operations there may be conflicts between the refresh function and the interrupts. To relieve the single chip microcomputer and, more importantly, to avoid conflicts during interrupt operations, a simple circuit was designed which allows the refreshing of DRAMs using the control signals of the single chip microcomputer.

### Operating Principle

The DRAMs are refreshed in the background of command call cycles. This requires a division of the single chip microcomputer memory space into data and program segments, i.e. the signal /DM at P34 must be enabled. Therefore, for a command call the single chip microcomputer accesses the program segment only. During this time, the data segment can be accessed simultaneously without affecting the computer's operation as long as the data segment is kept separate from the single chip microcomputer. This principle is used for refreshing the data memory.

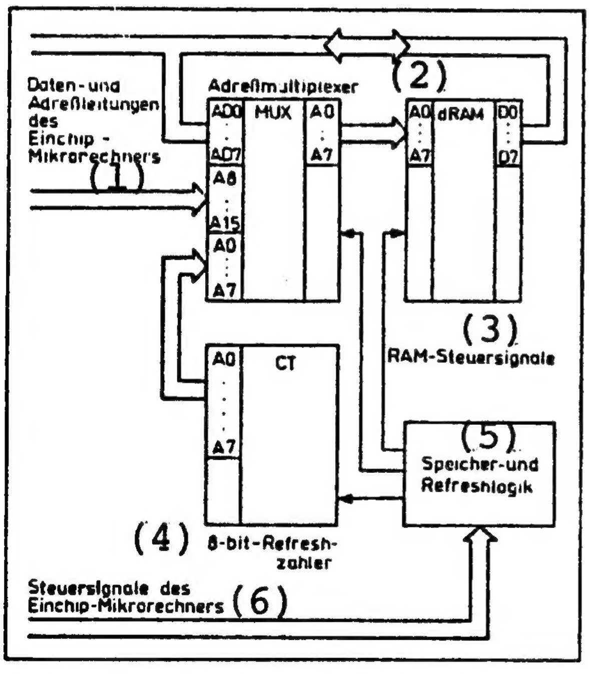



**Bild 1: Blockschaltbild der Refreshhardware**

**Figure 1. Block Diagram of the Refresh Hardware**

Key:—1.Data and Address Lines of the Single Chip Microcomputer—2.Address Multiplexer—3.RAM Control Signals—4.8 Bit Refresh Counter—5.Memory and Refresh Logic—6.Control Signals of the Single Chip Microprocessor

Signals /RAS and /CAS which are used to drive the DRAMs are generated by control signals /AS, /DS, /MDS. Since enabling of these control signals is inconsistent in some machine cycles (e.g. during the interrupt accept cycle, the LDE commands and Reset), the control signal /SYNC of the single chip microcomputer must be included in the refresh logic. The rising edge of /SYNC is always followed by a regular command call cycle [2].

For this reason, the memories are always refreshed during the machine cycle directly following the /SYNC signal, i.e. there is always exactly one refresh cycle for each command. With an external clock frequency of 8 MHz, all 128 columns are refreshed within 200 µs on an average without using computing time of the single chip microcomputer.

The refresh hardware consists of an 8 bit refresh counter, an address multiplexer to provide the refresh address and a refresh logic which generates the required control signals (figure 1). Since the basic circuit shown in figure 1 uses the signals /SYNC and /MDS of the single chip microcomputer it can only be used for the development versions U 882 and U 884, which are the only ones to provide the control signals mentioned.

### Circuit Description

Figure 2 shows the refresh hardware circuit, figure 3 the time diagram. DRAM selection follows basically the suggestion given in [2] ($D_6$, $D_8$ to $D_{18}$).

When the data memory is accessed, the signal /RAS is generated by $D_{10}$ from the rising edge of /AS. Multiplexers $D_8$ and $D_9$ switch lines AD0 to AD7 of the single chip microcomputer—where the low order address part is located at this time—to the DRAM address inputs. The /CAS signal is generated from control signal /DS by a delay in the gates of $D_6$, and the address multiplexers apply the high order address part (A8 to A15) to the DRAM address inputs. Signal /RAS is reset with the rising edge of /DS.

The R/W signal of the single chip microcomputer is used for the DRAM read/write control. The runtime performance of these signals [2] causes the DRAMs to function in the early write mode [1]. This allows parallel switching of the data inputs and outputs of DRAMs $D_{11}$ to $D_{18}$.

To be able to use the same memory refresh drive circuitry for accessing the internal ROM, the signal /MDS is included in the drive logic. Using the AND operation of control signals /DS and /MDS, the /DS* signal is generated which performs the same functions as /DS. /DS* is enabled both when the external memory and the internal ROM is accessed (see figure 3).

Since enabling of /MDS is inconsistent in some machine cycles, the refresh process is synchronized with /SYNC. The /RFSH signal is enabled during the rising edge of /SYNC and it is disabled again during the subsequent negative edge of /DS*. The AND operation of /DM and /RFSH results in the signal /RASE (RAS enable). The

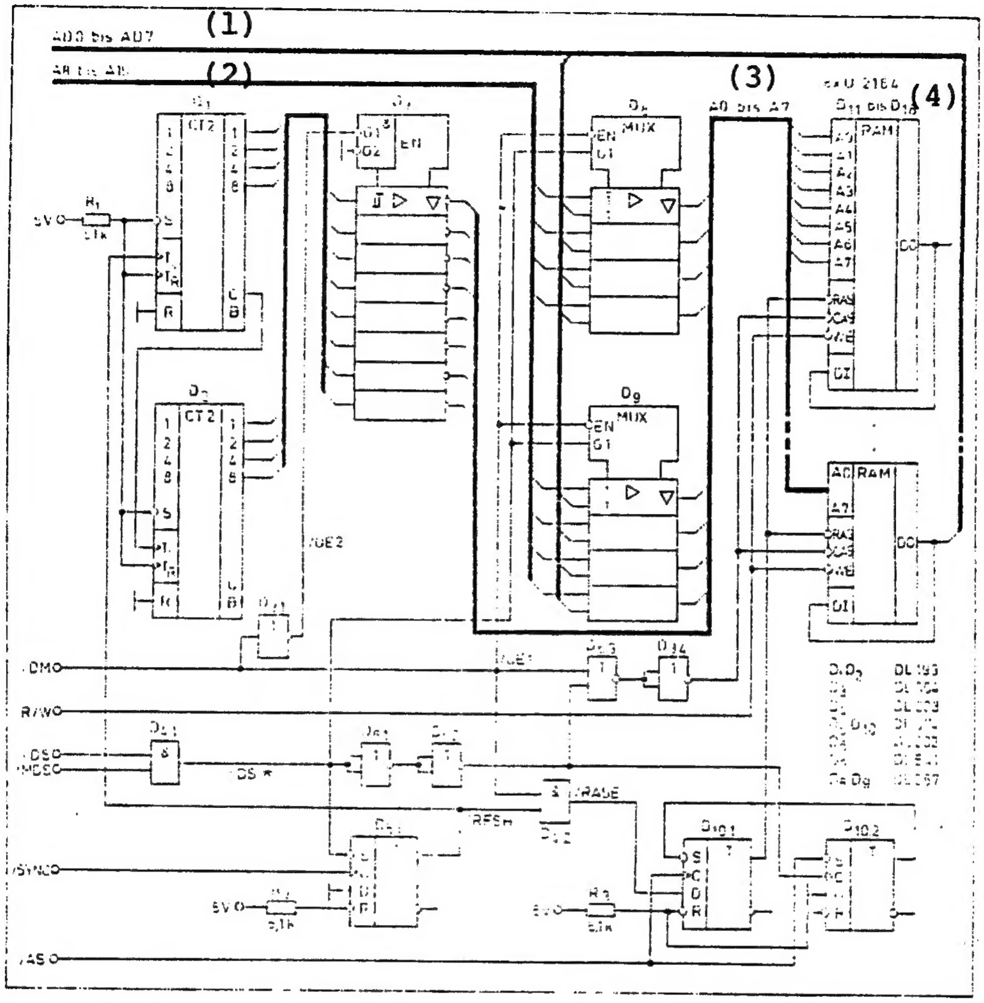



**Figure 2. Refresh Hardware Circuit Diagram**

Key:—1.AD0 to AD7—2.A8 to A15—3.A0 to A7—4.$D_{11}$ to $D_{18}$

/AS signal can enable the DRAM signal /RAS only when /RASE is active. Thus, /RAS can become enabled only when the single chip microcomputer accesses the data segment of the memory, or directly following /SYNC. In both cases, regular /As-/DS or AS-/MDS signal sequences are generated which prevent an incorrect memory selection.

The DRAM signal /CAS is switched via /DM ($D_{6,3}$). The /CAS signal is enabled only when the single chip microcomputer accesses the data segment; in all other instances it remains disabled. This allows a RAS-only refresh process [1]. Following /SYNC, /RAS is enabled and /CAS is disabled (see figure 3).

With the negative edge of /RAS, DRAMs U 2164 accept the address at address inputs A0 to A7 as a line address into the address latch. During a write or read access, this address is the line address of the memory cell selected, during a refresh cycle it is the current refresh address.

The refresh address is generated by an 8 bit refresh counter ($D_1$, $D_2$). To make counter timing less critical, the counters are not advanced until the DRAMs have accepted the refresh address during the rising edge of /RFSH. This gives the counter outputs sufficient time to respond to the new counter status. Thus, each refresh process uses the refresh address of the preceding refresh cycle.

To include the refresh address the tristate outputs of the address multiplexers $D_8$ and $D_9$ and of driver $D_7$ are controlled via signals /OE1 and /OE2 which are derived from /DM. If /DM is enabled, i.e. the data memory is accessed, the address multiplexers are open (/OE1 = L), and the respective memory address reaches the memory address inputs. Drive $D_7$ is disabled (/OE2 = H). If /DM is disabled, driver $D_7$ is enabled, and the counter passes the refresh address to the DRAMs. During that time, the address multiplexers are disabled, so that the memory can be refreshed (see figure 3).

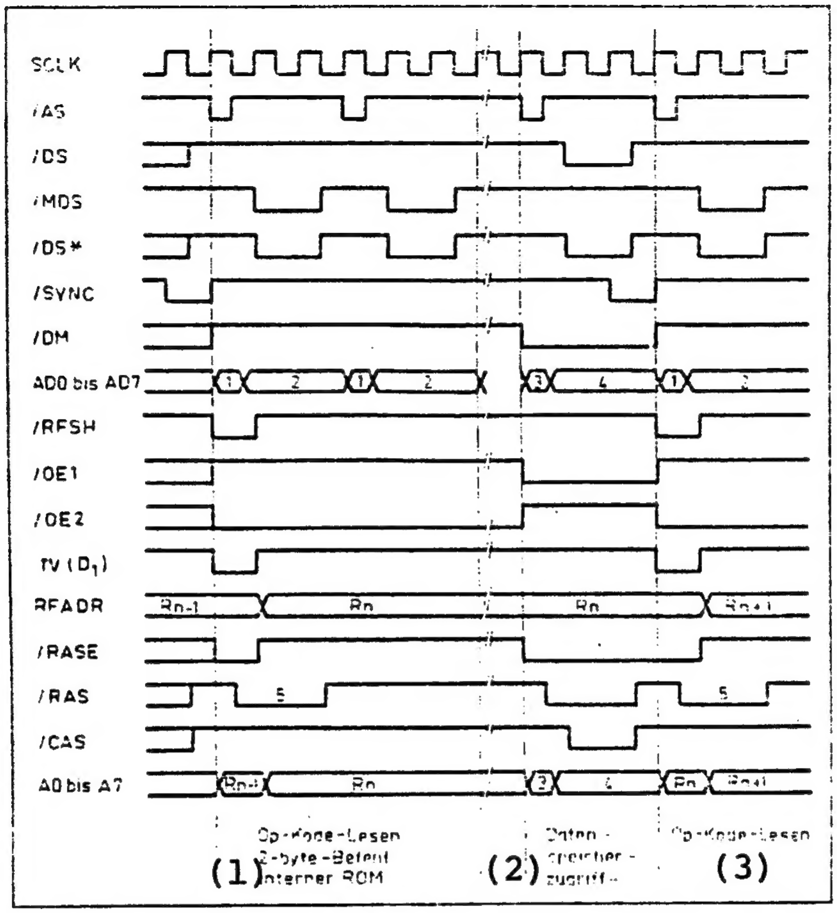



**Figure 3. Time Diagram for Memory Access and Refresh Cycles (1 Low Order Part PC, 2 Op-Code, 3 Low Order Part Memory Address, 4 Data, 5 RAS-only-Refresh)**

Key:—1.Op code read, 2 byte command, internal ROM—2.Data Memory Access—3.Op code read

**Summary**

The refresh hardware described allows the use of dynamic memories in systems with single chip microcomputers without using up their computing time for refresh routines. It also avoids time conflicts between refresh processes and interrupt operations. Timing was designed so that LS-TTL circuits can be used for the complete drive circuitry with external clock frequencies of up to 8 MHz [3]. Chip types such as the U 2164 C 25 with access times of 250 ns are sufficient for the DRAMs [1]. However, only chip types U 8820 and U 8840 can be used as single chip microcomputers since their special control signals /MDS and /SYNC are required for driving the refresh circuit. We did not study the possibility of using this hardware for single chip microcomputer types U 886 and U 8611 DC/1.

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